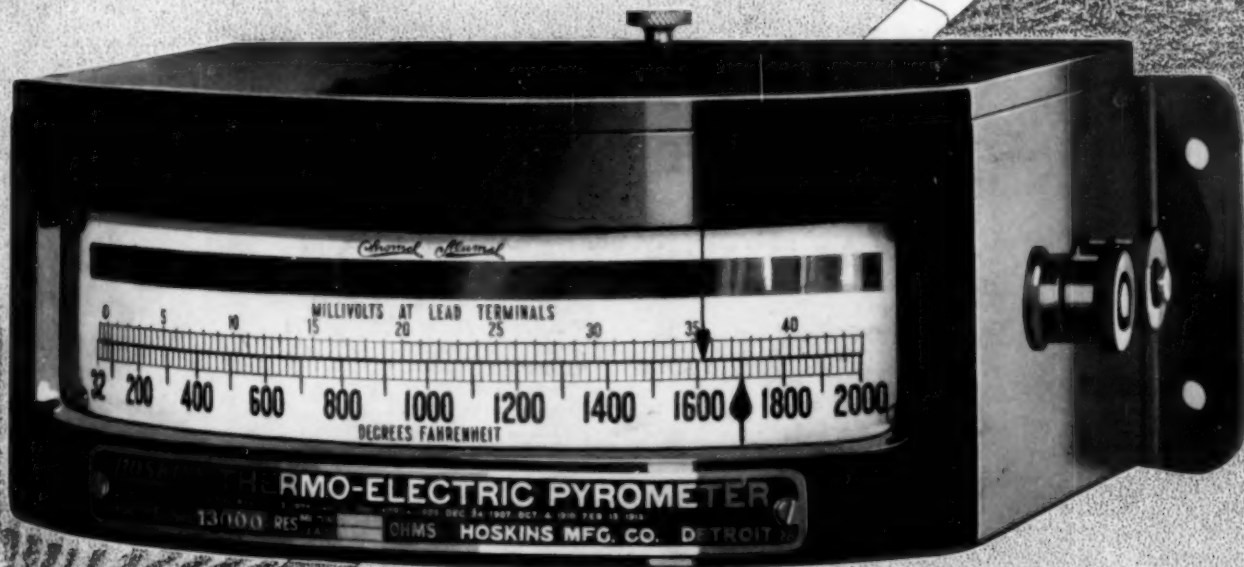


# CHEMICAL & METALLURGICAL ENGINEERING

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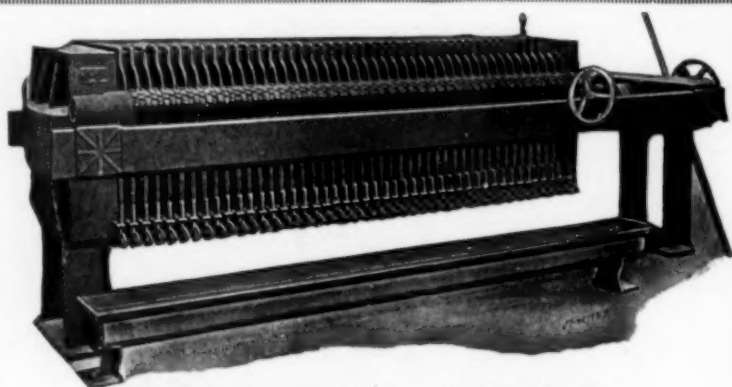
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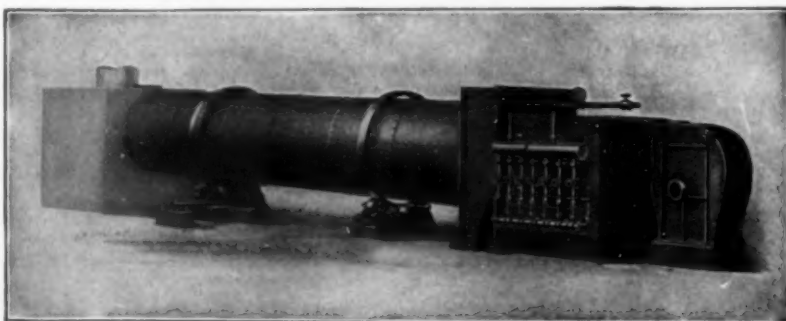
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### A New View of Gas Warfare

WHEN the Germans introduced poison gas as a means of attaining their military ends they were universally condemned for committing a fiendish act; and military critics referred to it as a reversion to the use of the stink-pot by the Chinese. It was, indeed, a detestable method of warfare that had not occurred to the Allies; or if it had occurred to them it was rejected as abhorrent. But in order to fight the devil with fire the Allied and American armies began extended research in the manufacture of poison gases and protective masks, and ultimately excelled their enemies in this mode of warfare, just as they did in all others. Indeed the Germans were being rapidly gassed into submission and would have been given still larger doses but for their sudden capitulation.

It is likely that our first unfavorable impressions of gas warfare have become fixed in our minds, so that a defense of the practice will be more or less shocking to the layman. From a military aspect, however, gas has such favorable possibilities that it is regarded in some quarters as one of the most effective and humane weapons of the future. Our readers will be especially interested in an article on another page giving the views of Brigadier General Amos A. Fries, who was recently interviewed by a member of our editorial staff. General Fries was in charge of the Chemical Warfare Service in France, and speaks from experience. He finds gas a weapon of great possibilities; effective against an unprepared foe, but of little or no avail where ample protection is provided. Less frightful in maiming and wounding men, it is more humane than shrapnel and high-explosive shells; and there is a lower death rate from gas casualties than from those caused by gunfire. As a means of rendering mobs tractable, lachrymator gases may find useful application in civil life. On the whole there seems to be a possibility of developing this unhappy offspring of iniquity into something useful, and we commend a careful reading of General Fries' views.

### Dislocation of the Copper Industry

ARGUING, at this late date, the wisdom in the continuance of copper production at a maximum rate after the signing of the armistice had absolutely killed the market both for governmental and individual account is hardly of value. The large producers and the Government must have seriously misjudged the American and the world market conditions in order to have piled up a billion pounds of high-cost copper, finished and in process—the present visible stock,

according to reliable estimates. November and December passed without a single large sale. Organizing to control export trade, the copper producers formed a *de facto* trust and in January set the export price at 23 cents—purely a figure of hope, since foreign companies could readily cover current needs by purchasing the reserve stocks held by their Governments at a materially lower figure. Nothing prevented the American producers from almost unanimously asking 23 cents for local delivery; on the other hand, nothing forced American consumers into buying at that price. In the face of this stalemate, curtailment became the order of the day, and at present the output is probably at the rate of 100,000,000 pounds per month.

A reduction in output to about 60 per cent normal naturally laid off a number of men in the mines and mills. Avoidance of serious unemployment was perhaps the sole justification of previously maintaining large over-production. This surplus labor added to the ranks of returning soldiers created such a serious outlook that Secretary of Labor Wilson held a conference with labor union representatives from Montana, Utah and Arizona early in February to solve if possible the riddle. These meetings listened to a statistical statement of the present copper market, an address from John D. Ryan, explaining the financial position of the producing corporations, and various schemes from the workmen designed to maintain war-time wages and employment.

This seems impossible of attainment. Sales in quantity began to occur during the first week in February at a fraction over 18 cents. Immediately thereafter the large producing companies posted notices that the wages would again be determined by a sliding scale, based on the market price of the metal, a system largely used in the industry and in many camps sanctioned by contracts between companies and unions. In the absence of any market, wages for February will be figured either on a basis of 20-cent January copper or on the daily current price (depending upon custom); either plan will involve a horizontal wage reduction of from 75 cents to \$1 per day. Even at this, the daily rates are 50 cents or more higher than existing agreements call for, since the wages recently paid were accepted as the scale for 26-cent copper, while as a matter of fact, it more nearly approximates the 30-cent scale, maintained without reduction by agreement with the War Industries Board. The Anaconda Copper Mining Company also announced that no further decrease in wages is anticipated, should the market fall below 17 cents.

The unfortunate feature of the labor situation in the copper industry is that the miners decline to accept the wage reduction which accompanies the decreased price for the metal. The sliding wage-scale based on metal prices is always acceptable to the miner as long as prices are rising, but his memory is rather short when the time comes for him to perform his part of the contract and accept the wage reduction. The consequence is that mining and milling operations are practically suspended in the Butte district owing to a strike fomented by the notorious and vicious I. W. W. The fear has been expressed that the dissension will spread throughout the other Western copper districts.

We can imagine that the companies will be glad of an excuse to close their properties in view of the present high cost of production and the prospect of a falling market. The miners have nothing to gain except through a straightforward and generous acceptance of their share of the loss which the sudden ending of the war brought to the industry.

#### Proposed Improvements in American Patent Procedure

WHEN the Commissioner of Patents in 1917, with the approval of the Secretary of the Interior, requested the National Research Council to investigate our Patent Office and its procedure, a step was taken which we are so bold as to believe will result in remedying some of the imperfections on our patent system. These have long been apparent to those who have much to do with the Patent Office. Considering the vital part played by this institution in our national life, it is important that it be made as efficient and effective as possible. No organization is better qualified than the National Research Council to appreciate the excellence or deficiency of the Patent Office, and the recommendations of a committee from that body should carry weight with Congress when it is asked to pass the necessary bills.

In a report of the patent committee to the Council it is recommended that a simple program of four features be adopted, and that the necessary legislation be obtained from Congress to put the proposals into practice. The first proposal concerns a single Court of Patent Appeals to supersede the nine Circuit Courts of Appeals, as far as patent cases are concerned. The second recommends that the Patent Office be made a separate institution, independent of the Interior or any other department of the Government. The third relates to substantial increases in the force employed in the Patent Office and in the salaries paid. The fourth seeks to make it possible for a patentee to obtain not only an injunction against an infringer in a case where a patent is adjudged valid, but also a reasonable royalty or other form of general damages.

There is no doubt that some step should be taken to remedy the farcical situation which can and does now arise in the adjudication of patents by our Circuit Courts of Appeals. As matters stand at present it is possible for the same case to be decided differently in two different circuits. Obviously a single agent is much preferable to nine having equal authority. But the question has been raised previously as to the wisdom of adjudicating patents *after* they have been granted instead of *before* they are issued. Those to whom letters patent have proved an expensive form of introduction to the Supreme Court have some ground for feeling that a court of experts weighing the claims of contestants before a patent is issued would be a quieting factor in our industrial life. Perhaps the committee of the National Research Council has considered this alternative and has concluded that a Court of Patent Appeals is preferable. Certainly it will be much preferable to our present courts for patent cases.

The movement to make the Patent Office a separate institution is believed to be in the interest of better administration. At present the Secretary of the In-



terior is at best a figurehead in its affairs, and the Patent Office suffers by irrelevant comparisons with other bureaus in the Department of the Interior. Only the highest approval can be given to the recommendation that the force of examiners and clerks be increased and that their salaries be raised to figures comporting with their ability. It is a reflection on the country that the salaries of examiners have been increased only 10 per cent since they were fixed in 1848! As to compensation for infringement of patents, we are in accord with the committee in seeking to secure a financial return to an inventor whose rights are violated.

Injunctions buy no bread for the winner, nor do they constitute a serious punishment to the loser. Money compensation would be more tangible justice to the inventor and probably a stronger deterrent against deliberate infringement.

### Restoring the Dollar's Value

**T**O RE-ESTABLISH business on a sound basis, indeed to re-establish industrial activity at all, it is necessary that the old-time value of the dollar be largely restored. It is impossible to change suddenly the value of the dollar and then have everything move substantially as before. No real prosperity can occur. The proper conception of prosperity is that of making progress, of obtaining new things. A state of society is conceivable in which men would merely produce the same quantity of material year in and year out, consume the same quantity, and be contented. They would merely be doing the same things over and over again. To conceive such a condition requires much imagination, for the concept is not in keeping with our traditions or habits of thought. Often we say that the luxuries of one day become the necessities of the next, which of course means that progress is essential to contentment, for while one might get along without luxuries and be somewhat contented he would certainly not be contented when those articles had become necessities.

Prosperity, then, not merely being busy but making progress, means development, doing new things, making new products. All this involves the providing of additional facilities, for which capital must be expended, changing from liquid to fixed form. More or less the capital invested in any year comes into competition with the capital that was invested in previous years. If the capital already invested was at a certain scale of values, of prices for commodities and labor involved in making the investment, and the new capital must be invested with a much higher scale of values obtaining, the competition places the new capital at a great disadvantage.

At a time like this capital shrinks from seeking investment in works of construction, which are necessary to our prosperity and advancement, both because it must come in competition with capital already invested to better advantage and because it faces the menace of a future time when it may be possible to invest capital to better advantage, through lower prices then obtaining for labor and materials.

If the investments now existing in the country had

appreciated in intrinsic value, keeping pace with the reduced purchasing power of the dollar, the condition might not be unsatisfactory. Things might possibly work out fairly well. This, however, is not the case by any means. The wealth of the country is not estimated at much more than before the war-time inflation occurred. The plight of most public service corporations is a practical example. If, assuming that the purchasing power of the dollar has been cut in half, the value of their properties, measured in dollars, had doubled, they would obviously be in very happy position; but the actual fact is that through the decreased purchasing power of the dollar their cost of operation is increased and the intrinsic value of the properties is decreased rather than increased. High wages cannot maintain high commodity values, nor can high commodity values maintain high wages. The value of existing properties, buildings, bridges, power plants, factories and other investments can, however, exercise an influence to pull down investment costs when they are so high that capital does not seek outlet through such investments. Inevitably this pulling down process is going to occur, and it is unwise not to face the fact squarely. If through lack of understanding people do attempt to resume full-time activity without the necessary adjustments having been made, there will simply be so much the more to adjust at some later time.

No one, of course, can intelligently argue that pre-war conditions and prices must return, or ever will return in full. To an extent conditions have changed. The position of labor has been altered by the war and former conditions will never be fully restored. The common laborer wants more, and will get more, for his labor in proportion to the pay of the more highly skilled man.

The war has shown that it does not require so long for a man to become skilled after all, and the fact that a man's work is skilled and therefore interesting is going to be taken as part of his reward for doing the work. Furthermore, the change that has been working for centuries must be regarded as having been in operation, double time, during the period of the war. The value of the dollar decreases from century to century. In 1897 and 1898 very low prices obtained in the United States. In succeeding years prices advanced rather steadily and there were those who looked for them to return eventually to the old level. That was a mistaken apprehension. Whether it is the increasing volume of money and credit, according to the quantitative theory, or a combination of influences, need not be discussed. It may be accepted as reasonably certain that with various fluctuations the value of the unit of money tends to decrease. If the price of a given commodity declines, it is merely a temporary fluctuation, an adjustment of a too great advance previously, or a decrease in the cost of producing the article.

Thus commodity prices and wage rates cannot be expected to be restored to the plane which they occupied before war was declared, but there must be a very considerable readjustment in that direction before industry can go ahead, development be undertaken and the people become really prosperous.

## Western Chemical and Metallurgical Field

### Secondary Mining Schools in Nevada

THE fifth session of the prospector's short course was held at the Mackay School of Mines at Reno, Nevada, during January. The majority of those attending were miners and mining men, although there has always been a considerable number of other trades or professions who are interested in prospecting as a side issue. Such courses offer a good opportunity for one to brush up his knowledge of prospecting, assaying, mineralogy and geology.

While similar courses have been instituted in several Western mining schools, the Mackay school at Reno is unique in instituting a system of secondary mining education for miners and mill-men, which includes a traveling mining school, which moves from camp to camp, visiting any localities which obtained an advance registration of at least twenty men, and continuing for one or two periods of three months as the attendance warranted.

Beginning with one school, operated as an extension department of the University of Nevada, the system has grown until it now consists of five distinct schools. Four of these are permanently located at Virginia City, Tonopah, Goldfield, and Ely, while the fifth is a traveling school at present in session at McGill. The only requirement for entrance into these schools is the ability to talk and read English, and while the instruction is elementary and practical in character thirty-seven different courses are offered and may be combined into various groupings sufficient to better the training in many vocations. The regular class work consists of two hours daily, which is as much as can be expected from men who are working continually at their trade. Instruction is given at two different two-hour periods to accommodate men working on different shifts, but the laboratories are open at all times during the week.

It is evident that in these schools no attempt can be made to train mining engineers and metallurgists. The object rather is to acquaint the student with some of the technical theory underlying his everyday work, thus making him a more intelligent and efficient workman and citizen. The young men who have a common school education and who do well in these secondary schools are offered every encouragement to go to the Mackay School of Mines for engineering training.

### 1918 Mineral Production in British Columbia

BROADLY speaking, the industrial conditions during the past year have not been unsatisfactory; and while it is not anticipated that the production will equal the record of 1916, it should compare very favorably with that of 1917. According to the January Bulletin of the Canadian Mining Institute, the production of coal for the nine months of 1918 showed an increase of 255,188 tons as compared with the output for the corresponding period of 1917. Production during the last quarter of the year has been well maintained despite the fact that operations, especially in the Crownsnest area, have been impeded by strikes and by the recent epidemic of influenza. So far as copper is concerned the total output for nine months of 1918, according to

the official records, was 45,518,223 lb. as compared with a total production during 1917 of 59,700,565 lb. The value of the silver produced owing to the advance in the market price of this metal is likely to show an increase over last year; the lead and zinc output will probably be less than last year. The suspension of operations at the Rossland mines for a considerable period during the year will inevitably affect the showing as regards the province's gold production, but this has been more than offset by the entry of the Surf Inlet mine into the productive class. Preliminary figures follow:

Placer gold.....	\$300,000
Lode gold.....	\$3,627,500
Copper, pounds.....	62,000,000
Silver, ounces.....	2,460,000
Lead, pounds.....	20,500,000
Zinc, pounds.....	23,055,000

### Manufacture of Pure Stick Caustic Potash

AMONG the many chemical products obtained exclusively from Germany before the war is caustic potash in the form of pure white sticks, having a content of 85 per cent or more of KOH and designated as the U. S. P. quality. The chemical literature is lacking in description of processes for making this material, especially from the grades of raw material available in this country during the past two years. In establishing a plant having a capacity for producing this material of 1000 lb. per day the C. F. Burgess Laboratories claim to have developed a strictly American process for producing a U. S. P. grade of caustic from American raw materials.

The raw materials employed are crude caustic from wood ashes and potash derived from the alunite process. The white sticks as marketed are about 10 cm. in length and weigh approximately 10 g. While the tonnage demanded for this product is small, it is nevertheless important for laboratory use, in gas analysis, in pharmaceutical preparations and in various chemical products such as special shaving soaps and the like.

### Penn-Wyoming Copper Co. Sold

WE HAVE been advised that the entire assets of the Penn-Wyoming Copper Co., Encampment, Wyoming, owner of the Saratoga & Encampment Railroad, the Ferris Haggerty and Doane-Rambler mines at that place, have been purchased by the Morse Bros. Machinery & Supply Co. of Denver, Colo.

The various subsidiary companies purchased and their respective bond issues follow:

Ferris Haggerty Copper Mining Co.....	\$1,000,000
Battle Lake Tunnel Site Mining Co.....	750,000
Saratoga & Encampment Railroad Co.....	750,000
Encampment Smelting Co.....	500,000
Encampment Tramway Co.....	350,000
Encampment Pipe Line Ditch Co.....	100,000
Emerson Electric Light Co.....	50,000
Encampment Water Works Co.....	50,000
Carbondale Coal Co.....	20,000
North American Mercantile Co.....	22,000
Encampment Town Lot & Land Co.....	6,000
Total bond issues.....	\$3,600,000

The stock of the Penn-Wyoming Copper Co. was \$10,000,000. This company was the successor of the North American Copper Co., the promotion of WILLIS GEORGE EMERSON, who recently died in Los Angeles, the Penn-Wyoming company taking over the property in 1904 and operating it under the most unfortunate conditions of fire losses and financing of the railroad until 1907, when it was closed. Numerous attempts were made to reor-



ganize and resume operation. Company dissension arose during the efforts to reorganize, a receiver was appointed and litigation commenced which only ended in the Court of Appeals. The sale of the property to the bondholders' protective committee and the purchase by the Morse Bros. Machinery & Supply Co. from that committee brings the history to date of a mine with a record of having produced more than 10,000,000 lb. of copper since its discovery in 1898 by ED HAGGERTY.

The records of the Penn-Wyoming Copper Co. show a production of 6,414,011 lb. of copper from 59,000 tons of ore mined. From 1904 until operation ceased in 1907 the plants were operated a total of 372 days. In 1906 the concentration and power plant was destroyed by fire but was rebuilt and put in operation the latter part of March, 1907, and operated until May 10 of that year, when the smelter and tramway terminal were destroyed by fire. These plants were rebuilt and began operation in May, 1908, and were operated until closed down in October of that year owing to financial difficulties occurring through the building of the Saratoga & Encampment Railroad, which connected the smelter at Encampment with Wolcott, Wyoming, on the main line of the Union Pacific Railroad. Previously all of the coke and supplies were hauled in and the finished product was hauled out to Wolcott, the nearest railroad point 47 miles distant.

The tramway connecting the Ferris Haggerty mine with the smelting works at Encampment is one of the longest aerial tramways in the world, its length being 16½ miles. It is operated in three sections, with a power plant at each section. There are 304 towers, tension and anchor stations, 884 buckets and 63 miles of wire rope. The track cables are 1½ in. and 1 in. and the traction cables ¾ and ¾ in. The cost of operation during the period was \$0.9347 per ton of ore handled.

Twelve cars of ore shipped from the Doane-Rambler mine in 1901 averaged 40.7 per cent copper, and exhibits of ore from this mine at the St. Louis Exposition showed values of 900 lb., or 45 per cent, copper to the ton, these ores being bornite and chalcocite. This mine was bought to supplement the production of the Ferris Haggerty and has been developed to a depth of 665 ft. No ore has been taken out from the lower levels.

The Saratoga & Encampment Railroad runs directly south from Wolcott to Encampment, which is at the foot of the Continental Divide, at one of the lowest passes in the range. A survey has been made to connect this line with the Moffat Road at Steamboat Springs, a distance of sixty miles on a 2 per cent grade and a maximum altitude of 8500 feet.

The geological features of this district, many of which are interesting, are fully described in Professional Paper No. 25 by A. C. SPENCER of the Geological Survey, published in 1904.

An effort will be made by the purchasers to prove the value of the mines and have them operated if investigation will warrant the expenditures necessary. The smelter and concentrating plants at Encampment will be dismantled and the material sold, as concentration mills will be built at the mines and the concentrates transported to Encampment. Millsites and water rights are available at both the Ferris Haggerty and the Doane-Rambler mines.

### California Mineral Production in 1918.

FLETCHER HAMILTON, the California State Mineralogist, has issued a preliminary statement of the mineral production of California which shows a wider variety of chemically valuable minerals than almost any other state in the Union and of a total value exceeded only by the large coal and iron producing states of the East. Gold decreased nearly \$3,000,000 in value, while petroleum increased 5,000,000 barrels in quantity. Quicksilver dropped off about 2000 flasks, while manganese ores nearly doubled. Magnesite, however, dropped to 40 per cent of the previous year's total on account of the competition of the cheaper, iron-bearing magnesite from the state of Washington.

The estimated quantities and values for 1918 are:

Gold	\$17,250,000
Silver (1,500,000 oz.)	1,450,000
Tungsten concentrates (2,300 tons)	3,000,000
Copper (49,000,000 lb.)	12,000,000
Lead (15,000,000 lb.)	1,100,000
Zinc (4,500,000 lb.)	375,000
Quicksilver (22,000 flasks)	2,310,000
Antimony, iron, molybdenum, platinum	90,000
Petroleum (100,000,000 bbl.)	123,000,000
Chromite (52,000 tons)	2,000,000
Manganese ores (25,000 tons)	1,125,000
Magnesite (90,000 tons)	900,000
Natural gas	3,000,000
Brick, cement, building stone, crushed rock, etc.	10,000,000
Miscellaneous "industrial" minerals	1,500,000
Salines (including borax, soda, salt, potash)	12,000,000
Total	\$191,100,000

### Company Reports.

**Tomboy Gold Mines Co.**—The annual report of this company for the year ended June 30 has just been issued. It shows that 151,000 tons of ore were milled at a cost of 70 cents per ton, yielding bullion worth \$306,000 and concentrates worth \$662,000 at a cost of 63 cents per ton. Tailings to the amount of 129,000 tons were cyanided at a cost of \$1.08 per ton, yielding bullion worth \$168,000. A marked shortage and inefficiency of labor has increased costs materially, and caused a reduction of ore reserves. Continuous tests were carried out from February to July with milling ore, so as to establish a reliable comparison between flotation and the present methods of treatment. The results confirmed the advantage of the flotation process, and it will make available large tonnages of developed low grade ore on the property. However, under the present condition of the labor and materials market, installation will be postponed.

**The Coniagas Mines, Ltd.**—The report for the year ended Oct. 31, 1918, shows that the mine at Cobalt and the smelter at Thorold, Ontario, have been operating continually. The tonnage milled was 68,597, or an average of 3.38 tons per stamp-day. From this ore was shipped 530 tons of high-grade concentrate containing 1164 ounces per ton, and 867 tons of slime concentrates containing 245 ounces of silver per ton. Mill heads averaged 15.94 ounces per ton and the tailings were reduced from 3 ounces to 1.75 by the use of the Callow flotation plant, which superseded canvas tables and cyaniding. Mining and concentrating cost 33.87c. per ounce of silver recovered, smelting and marketing 7.98c., while the output was sold for 94.14c. The average cost per ounce of silver produced during the twelve preceding years has been 16.3c. Re-treatment of the sand tailings pile was begun in May and continued until November, during which time 22,000 tons of an average value of 3.5 ounces were treated.

## Report of the Patent Committee to the National Research Council

THE Commissioner of Patents in 1917, with the approval of the Secretary of the Interior, requested the National Research Council to appoint a committee to investigate the Patent Office and patent system, with a view to increasing their effectiveness, and to consider what might be done to make the Patent Office more of a national institution and more vitally useful to the industrial life of the country.

Mr. Thomas Ewing, who is a member of the Patent Committee, was the Commissioner of Patents who took that action.

The National Research Council, complying with the request, appointed a Patent Committee, consisting of: Dr. William F. Durand, chairman; Drs. L. H. Baekeland and M. I. Pupin, scientists and inventors; Drs. R. A. Millikan and S. W. Stratton, scientists; Dr. Reid Hunt, physician; and Messrs. Frederick P. Fish, Thomas Ewing and Edwin J. Prindle, patent lawyers. On the departure of Dr. Durand for Europe, Dr. Baekeland was appointed Acting Chairman of the Committee.

### FOUR CHANGES RECOMMENDED

The Committee has concluded to propose a program consisting of but four features, because it believes those features are of such fundamental importance that their enactment into law would strengthen the entire system and directly and indirectly establish it upon a new and much more advantageous footing before Congress and the public; and because with a simple program, presenting comparatively little opportunity for difference of opinion as to the desirability of the changes proposed, there would be a unanimity of opinion in support of it which could not be obtained if the program were more extended.

### A SINGLE COURT OF PATENT APPEALS

The first proposal is the establishment of a single Court of Patent Appeals that will have jurisdiction of appeals in patent cases from all the United States District Courts throughout the country, in place of the nine independent Circuit Courts of Appeals in which appellate jurisdiction is now vested.

The existence of nine appellate courts of concurrent jurisdiction in patent cases works serious hardships. While, theoretically, the law is the same in all of these courts, there has been an irresistible tendency to drift apart in the application of the law. It has even happened in a substantial number of cases that two of the appellate courts have taken a different view of one and the same patent.

### WOULD BENEFIT INDUSTRY

It would be of the utmost value to those in the United States who are engaged in industry if the present confused condition could be corrected and a single tribunal devote itself to crystallizing the fundamentals of the patent law and to educating the courts throughout the land to uniformity in applying these principles in special cases.

A bill is suggested for the establishment of such a Court, which has been advocated for many years by the American Bar Association, and is No. 5011, of

the House of Representatives, 65th Congress, 1st Sess. It provides for a court of seven members, which would sit in Washington, with a Chief Justice appointed for life by the President. The appointment of the Chief Justice for life is in order that there may be an element of continuity in the Court. The other Judges are to be selected by the Chief Justice of the United States Supreme Court from the various District and Circuit Judges throughout the land, and each is to sit on the Court of Patent Appeals for a period of six years, or longer, if reappointed.

### THE PATENT OFFICE A SEPARATE INSTITUTION, INDEPENDENT OF THE DEPARTMENT OF THE INTERIOR

The second proposal is that the Patent Office be made a separate institution, independent of the Interior or any other department. The Patent Office was originally in the State Department, but, on the formation of the Interior Department in 1849, it was made a bureau of that Department and has been so ever since.

The Committee believes that to make the Patent Office an independent bureau would greatly increase the respect of the public and Congress and the courts for it, and would make it easier to procure enlarged appropriations and better salaries than under present conditions.

A copy of a proposed bill for making the Patent Office an independent bureau is annexed to the report and its enactment is recommended by the committee.

### INCREASE IN FORCE AND SALARIES OF THE PATENT OFFICE

The third proposal which the committee recommends is a substantial increase in the force and salaries of the Patent Office. The patents granted by the United States Patent Office are of less average probable validity than formerly, because the number of applications for patent and the field of search are constantly increasing, while the examining force for many years has been insufficiently large and has not been increased proportionately. The inducements are so unattractive that twenty-five per cent of the examining force has resigned within the past three years. The salaries of the Patent Office examiners have been increased only ten per cent since they were fixed in 1848, when they were approximately the same as those of members of Congress. At the time the salaries of the Examiners-in-Chief were fixed, they were the same as those of Federal District Judges.

### LOW SALARIES PAID

During the past seventy years, the compensation for technical service in almost all other directions has been increased very largely.

Congress, in creating new positions, is willing to pay technical men salaries more nearly approximating the usual compensation of such men in private service, but, having started a position at a given salary, is very loth to increase the salary. A Principal Examiner, to pass the entrance examination for the Patent Office, must himself have an education equivalent to that of a college graduate, and yet his salary is so low (\$2,700 a year) that it is practically impossible for him to give



his own sons a college education. The committee believes that salaries should be paid to the examiners proportionate to those paid for equally high technical work in other departments created recently.

Recently there have been two or three decisions in which the courts have taken a more liberal attitude, holding in effect that where an invention has been used by an infringer a reasonable royalty may be awarded to the patentee based on a mere estimation or on opinion evidence, even though no exact computation can be made.

An amendment has been proposed to Section 4921, the Revised Statutes of the United States, reading as follows:

"If proof is not offered or, in the absence of adequate proof of the amount that should be awarded as damages or profits, the court, on due proceedings had, may adjudge and decree to the owner payment of a reasonable royalty or other form of general damages."

This proposed amendment would enable the patentee in all suits where the patent has been found valid and infringed to recover at least a reasonable royalty, and would provide a money recovery in the great majority of patent suits where no recovery would otherwise be possible.

### Research Vacancies in the University of Illinois

THE University of Illinois announces that at the close of the current academic year there will be eight vacancies to be filled in the research graduate assistantships maintained by the Engineering Experiment Station of the university. In addition there are available two research graduate assistantships in gas engineering, which are supported by the Illinois Gas Association. These assistantships, for each of which there is an annual stipend of \$500 and freedom from all fees except the matriculation and diploma fees, are open to graduates of approved American and foreign universities and technical schools who are prepared to undertake graduate study in engineering, physics, or applied chemistry.

Appointments are made and must be accepted for two consecutive collegiate years, at the expiration of which period, if all requirements have been met, the degree of master of science will be conferred. Not more than half of the time of a research graduate assistant is required in connection with the work of the department to which he is assigned, the remainder being available for graduate study.

Nominations to these positions, accompanied by assignments to special departments of the Engineering Experiment Station, are made from applications received by the director of the station each year not later than March 1. The nominations are made by the executive staff of the station, subject to the approval of the president of the university. Nominations are based upon the character, scholastic attainments and promise of success in the principal line of study or research to which the candidate proposes to devote himself.

Preference is given those applicants who have had some practical engineering experience following the

completion of their undergraduate work. Appointments are made in the spring, and they become effective the following September.

The Engineering Experiment Station, an organization within the College of Engineering, was established in 1903 for the purpose of conducting investigations in the various branches of engineering and for the study of problems of importance to engineers and to the manufacturing and industrial interests of the State of Illinois. Research work and graduate study may be undertaken in architecture, architectural engineering, ceramic engineering, chemistry, civil engineering, electrical engineering, mechanical engineering, mining engineering, municipal and sanitary engineering, physics, railway engineering, and theoretical and applied mechanics.

Additional information may be obtained by addressing the director, Engineering Experiment Station, University of Illinois, Urbana, Illinois.

### Secretary Lane Seeks Survey of Power Resources

Secretary Lane of the Interior Department has sent to Congress requests for two appropriations for special investigations and report on the power supply. One of these is a request for an appropriation of \$50,000 for a survey of the power resources all over the United States. This proposed appropriation is embodied in the Sundry Civil Bill, hearings on which are now being held before the subcommittee of the House Committee on Appropriations. If approved, the work would be done by the Geological Survey. The other request is for an appropriation of \$200,000 for a report on the power supply for the industrial region of the northern Atlantic seaboard, extending in general from Boston to Washington. If approved, this work would be done by the Geological Survey and the Bureau of Mines in co-operation. The request for the \$200,000 appropriation has been approved by the Secretary of the Treasury, and has been forwarded to Mr. Swager Sherley, chairman of the House Committee on Appropriations.

### Deadlock on Water Power Legislation

The water-power conferees of the Senate and House of Representatives have held another meeting lasting for three and one-half hours, and are again deadlocked upon the same question which has prevented the passage of a water-power bill for five years, namely, the question of the charge to be made.

The Washington representative of CHEMICAL & METALLURGICAL ENGINEERING reports that Senators insist that no charge shall be made for the use of water, on constitutional grounds, while the House conferees are insisting that the language of the House bill shall be used, which would give to a proposed Federal Power Commission the right to make a charge for water.

The attitude of those in Washington who are familiar with this proposed legislation is that the charge which would be made is so small in comparison with the benefits to be derived that the Senate could well recede from its position. The conferees adjourned subject to the call of the chairman, and will try to hold another meeting Monday.

## Chemical Warfare—A New Weapon

Novel Views on the Future of Gas Warfare Expressed by Brigadier General Amos A. Fries—  
Lower Death Rate From Gas Casualties Than From All Others—The  
"Humanity" and Effectiveness of Gas Warfare

BY ELLWOOD HENDRICK

**I**N August, 1917, Brigadier General Amos A. Fries, of the U. S. Engineers, was appointed to command the chemical warfare service of our Army in action. He has lately returned to the United States, and it was the privilege of the writer to spend a couple of hours in discussion with him concerning gas warfare and the chemical wing of the service. Gen. Fries has been awarded the rank of Commander of the Legion of Honor by the French Government.

The opinion seems to prevail generally that the use of poison gas, launched in breach of faith by the German High Command, has reached an end for all time; that by general agreement in convention it will no longer be endured, and that it is to be classed with the many practices of violence and debauchery of which the German army was guilty.

This is not in accord with General Fries' opinion. The Allied troops used chemical warfare in constantly increasing measure because it is an effective weapon. On the other hand atrocities were neither practiced, encouraged, nor permitted. It is General Fries' belief that the use of other chemicals besides shot and shell, having been introduced into the art of war, can never be eliminated. The situation is somewhat like that when gunpowder was introduced, and universally frowned upon as unfair and unsportsmanlike; yet it has endured.

### WHY CHEMICAL WARFARE WILL NOT BE PERMANENTLY SUPPRESSED

The principal reasons why gas and chemical warfare is unlikely to be permanently suppressed are because

It is the most humane method of fighting, if both sides are prepared for it, while

It is the most deadly of all methods to the side that is unprepared.

The "humanity" of poison gas we shall consider shortly; the first point is that the army that is prepared against it is unlikely to be severely injured, while that which is unprepared is almost certain to meet defeat in an attack. Now, wars are usually caused by the breach of agreements, and it is seldom that a nation at war trusts its enemy. And if the enemy by the use of chemical warfare is able to win, then its opponent will have to be prepared. War has not yet reached the stage of the code duello, whereby an impartial umpire may step in and declare the fight off if unfair practices are employed. So the only safety against defeat is to be prepared against chemical attack. This takes a long time and peculiar training, while most wars are of shorter duration than that with which we have lately been engaged. The old military axiom of safety in preparedness still holds good. When the Germans launched their first clouds of chlorine the road to the Channel

ports was open to them. The trouble was, as usual, that Fritz was a little slow in his thinking, and he missed his chance. The Allies obtained time enough, by a miracle of industry on the part of British and French women, to make preparations, and then, after gas warfare was started, the Allies thought faster than the Germans, and finally beat them at their own game.

Now in regard to the "humanity" of gas warfare, it should be remembered that the American troops were originally not prepared against it. Our men were saved by the British. No fewer than 700,000 British gas masks were furnished to us before the American masks arrived. Our first gas officers and troops were trained by the British, and so well trained withal that they avoided accidents. It was only by means of this help that we may be said to have been partially ready. Despite this defect in preparation the following figures are illuminating. Of our total casualties in battle about 30 per cent arose from gas, leaving 70 per cent caused by all other forms of attack such as bullets, shrapnel, machine guns, high explosive shells, etc.

### GAS CAUSED ONLY 5 PER CENT OF DEATHS

But while the gas wounded equalled 30 per cent of our casualties, deaths from gas were only 5 per cent of the total deaths. In other words, of each 100 wounded with gas 3 to 4 die, while of each 100 wounded with bullets, high explosive, etc., 20 to 25 die. Deaths from pneumonia and other lung complications following gassing are included in the 3 to 4 per cent given. Of the total casualties from other causes, 20 to 25 per cent died, and this does not include the men who are maimed. We have more than 3000 men who have lost either a leg or an arm, not to count those who have been blinded. There is no authenticated case of permanent blindness from gas. The U. S. authorities in the very beginning prescribed the use of gas in all shells from 3 to 8 in. in diameter, and finally, last summer, the list was made to include all shells up to 9½ inches.

Against savages or semi-civilized tribes gas warfare may be made as humane as is desired. Lachrymator or tear gas will cause temporary blindness so that enemy troops may be easily captured, though within a few hours the prisoners have their sight completely restored, and are not physically injured otherwise.

The training of gas troops is of primary importance. It is required of them that they use their noses to sniff out the first sign of gases. Sensitiveness to this grows as the men remain in the service. The men must know the hazards, and yet they must not be frightened so as to make them susceptible to panic. Protection must be adequate, but not a burden. Better a little hazard than discomfort which men cannot endure.



The entire system of defense needed to be changed with the advent of mustard (dichlorethylsulphide). Theretofore with chlorine, phosgene, diphosgene (trichlormethylchlorformate, etc.), the attacks were intense but short lived. Mustard, however, which boils at about 217 deg. C., remains in place, and in cold, still weather lasts more than a week after it has been spilled upon the earth. This requires a more comfortable protection and the necessity of moving troops from gassed to free areas. Very fortunately this necessary change in tactics was synchronous with the change from trench warfare to an elastic front.

Gas troops also are drilled in the use of Livens projectors and bombs, and Stokes mortars, both of which are British contributions. The Livens projectors are 8-in. drawn steel tubes, either 2 ft. 9 in. or 48 in. in length. These are loaded with loosely fitting bombs 8 in. in diameter and about 14 in. long. They are fired simultaneously in groups of 50 to 2500. The Stokes mortar is a 4-in. heavy tube, by means of which 25 to 40 bombs, fitted with fuses to break them open, may be fired per minute.

#### NEED FOR CHEMISTS AS OFFICERS

Practice also shows the need of 3 to 5 chemical warfare officers on the staff of each commanding general to augment the artillery, as well as gas troops to follow up the infantry. It is also desirable that of the Chemical Warfare Division in the field, at least 25 to 30 per cent of the officers be sound chemists.

Laboratories are absolutely essential, and these must keep in close touch with the field. Leading authorities are of the opinion that the greatest hindrance to the work of the National Research Laboratory in Washington was its inability to keep in touch adequately with the fighting line. The vast number of reports which were lost, including thousands of pages of supremely valuable data which never arrived, made the situation worse. There were sent from France during the six months 360 reports, and of these a great many have not been found to this day. Defective communications were among our most expensive troubles.

Laboratories should be recognized as an intimate part of the fighting machine, inasmuch as only by this means can the constantly changing problems of this scientific method of warfare be met. The lack of enough and of very capably manned laboratories in chemical warfare is no less than an invitation to defeat. With proper laboratory co-operation, however, chemical warfare offers the greatest range for ingenuity to both officers and men in the field and on the staff.

On the other hand it is of signal importance that chemical warfare be under military guidance, because purely laboratory methods give wrong and harmful results. An instance of this may be cited in the case of vincennite, a French preparation of hydrocyanic acid which, while remarkably toxic upon dogs, was little more than useless in the field. The British succeeded earlier than the French in achieving active co-operation between their military and chemical staffs, and they benefited accordingly, contributed more, and made fewer errors. As soon as the French obtained this co-ordination their progress was immensely accelerated. Errors of the following type are typical of laboratory work without mili-

tary communication and control: too tight elastics in masks, too long rubber mouthpieces, the wrong use of such a gas as vincennite, as stated above, etc.

The first American gas troops were trained by the British for three weeks. The first independent American gas attack was made along the front of the Rainbow Division in April, 1918, and so well did the troops acquit themselves that the regiment received the decoration of the Legion of Honor, and 26 Croix de Guerre were distributed among officers and men.

#### GAS TROOPS OF INCALCULABLE VALUE

As the art progressed it became part of every battle plan to answer the questions, "Where can we use gas?" and "Where can we use smoke?" Then as the battle proceeded the gas troops followed the infantry, and became of almost incalculable value in breaking up machine-gun nests. The method came from the collaboration of various branches of the Chemical Warfare Service, wherein Stokes mortar bombs were employed, containing thermit and white phosphorus. They were remarkably effective. One single shot brought out 77 boches, hands up and crying "Kamerad!" This is but an incident of the ingenuity of the chemical division when it is well organized. Thermit has its faults; it cools very quickly, but the phosphorus gave it a bewildering quality. Whenever a smoke screen was needed the chemical troops were at hand to provide it. Against a massed attack a few bombs of phosgene and diphosgene were very discouraging unless the men were adequately protected, for phosgene is quick in action and gives 20 per cent fatalities. It is, however, quickly dissipated. As the war neared its end our troops were able to protect themselves against a gas attack within fifteen seconds after the first flash.

#### SIZE OF AMERICAN CHEMICAL DIVISION

Another important service developed by the gas troops was the loading of Livens bombs filled with 30 lb. of TNT, of which they fired twenty or more at a time. As these bombs did not bury themselves in the earth they completely swept the area covered by them of every living thing. More than 1000 of these were made in the field in France and put over, and 2000 more were in the making. Here also screens of smoke were often followed by screens of gas. Again, the artillery would administer the doses while the chemical officers would select the medicine. So useful were these gas troops that by the spring of 1919 there would have been no fewer than 18,000 Americans in chemical service abroad.

Not only the need of laboratories but the absolute necessity for them has been mentioned already. The Germans shot their first mustard in July, 1917, and the Allies came back with it eleven months later. Also in October, 1917, the development of the gas mask for long-time wear was begun. The final American type, which was by far the best one made, was a modification of the French Tissot mask, which permits breathing naturally through the nostrils, and in which the eye-pieces are kept clear.

Another result of the research laboratory while under Colonel Bacon was the discovery that boiled linseed oil had a marked influence in retarding mustard burns.

Further research brought out the fact that this was due to metallic salts dissolved in it. It resulted in what was called "sag paste," a mixture of zinc stearate and vegetable oil, about half and half, which made an effective unguent. It did not prevent burns, but it took about six times the concentration necessary to cause burns without it.

#### CAMOUFLAGE GASES PREPARED

Camouflage gases were prepared to disconcert the enemy smellers. These were nearing completion at the time of the armistice. They made it impossible for Fritz to know what he was getting.

Other contributions in research were a saving of from one to two million dollars in specifications for camouflage paints, a fire extinguisher for aeroplanes, a new aeroplane glue, analyses of gases from German shells, the testing of masks, fabrics and smoke canisters or boxes attached to masks, because, while orders were given for each man to record the time he used his mask in gassed area, it did not work in practice. The men would not keep the records as prescribed while they were busy fighting.

Research both at home and in England resulted in technology superior to that of the Germans; indeed, toward the end of the war, the Germans' leading spy was operating in France and elsewhere to discover how mustard could be made in such quantity. The Germans at no time were able to produce over six tons of it daily. This superiority was evident as early as 1917, when rumors were rife that a German professor of humane tendencies was urging upon the International Red Cross the need of coming to a conclusion with the war, on the ground that by the spring of 1918 the Germans would launch such a fatal poison that it would produce nothing less than a holocaust among the Allies. It was suspected that this was an exponent of German fear rather than of German humanity, so word was sent back that the Allies hadn't really begun to fight with gas yet, and had no thought of quitting.

#### TROUBLES IN ESTABLISHING CHEMICAL WARFARE

As for the troubles which had to be met in establishing chemical warfare their name was legion. The first requirement was personnel, and there wasn't any. "State your requirements," said headquarters, and nobody knew what they were. Personnel was, however, finally assembled, and among the splendid corps of men the following are worthy of special mention:

Colonel E. J. Atkinson (West Point '08), of the First Gas Regiment, which went over as the Thirtieth Engineers.

Colonel Richmond Mayo Smith (of Plimpton Press, Norwood, Mass., and N. Y.), in charge of supplies.

Lieutenant-Colonel Byron C. Goss, in charge of gas warfare at the front, a wonderful instructor in the subject.

Colonel G. N. Lewis (University of California), whose military sense was equal to his quick and profound chemical understanding.

Major Carl Connell (New York University), who developed the final type of mask.

Major Zanetti (Columbia University), chief liaison officer, with the French.

Major Joel H. Hildebrand (Professor at University of California), in charge of experimental field and officers' gas school.

Colonel Raymond M. Bacon (Director of Mellon Institute), in charge of research.

Major Keyes (Boston Tech.), in charge of research laboratory in Paris.

Captain Boothby, who taught mask drill.

And many others.

There was also Colonel Harrison of the British Army, who was a tower of strength in getting gas masks from England to our men, by cutting red tape and coming to the rescue. He was engaged in pharmaceutical chemistry in London, enlisted as a private at the age of 46, and died last year as a Brigadier General.

It took two months from the time munitions left the United States to reach the army at the front. While this was not always the case, it was necessary to count upon such a lapse of time. And communications, so far as forwarding reports, etc., were concerned, were no less than desperate.

#### GAS INVITING FOR POLICE WORK, BECAUSE EFFECTIVE WITHOUT INVOLVING FATALITIES

In conclusion, while conventions may agree to forbid the practice of chemical warfare, it is, as we have said, a remarkable weapon of offense. Its employment places an army at so great an advantage over an unprepared enemy that it will be difficult to trust nations to forego its use. It is exceedingly inviting for police work, because it may be made effective without involving fatal casualties or maiming. The question, therefore, must be met whether future wars shall be controlled or not. If they are to be fought under international supervision, under rules akin to an international code duello—in which event it would seem that swords alone should be the proper weapon—then we have every reason to hope for the best, so long as the supervisors do not get to fighting among themselves. On the other hand, it may be that scientific warfare will be recognized, and allowed to develop until war itself shall be prohibited by some working agreement owing to its destruction of the world's accumulated property. Half-way measures and compromises will not meet the situation. And if there is to be an international police then chemical munitions will be needed to avoid unnecessary loss of life.

#### War Trade Board Rulings

*Export Licenses for Shipment to Switzerland*—Licenses will be issued freely for the exportation of the following commodities to Switzerland, if applications are otherwise in order:

Chemical products for pharmaceutical use, including chromic acid, hydrobromic acid, salicylic acid, arsenical salts for medicinal use, sodium bromide, sodium nitroprusside, silver nitrate, amidopyrin, betanaphthol, eucaine, paraldehyde, phenacetin, aconite and preparations of alkaloids of aconite, opium and preparations of alkaloids of opium; china clay; iron and steel (except high-speed steel); essential oils; all commodities when value of shipment is less than \$200.—W. T. B. R. 542 and 583.

*Wolfram*:—Licenses for importation of wolfram will now be issued freely.—W. T. B. R. 565.



## Electrolytic Deposition of Zinc

Preparation of Cell Liquor From Fumes Collected as a Sludge in the Acid Chambers—Details of the Theoretical and Applied Electrochemistry Involved, Together With Charts and Data

BY H. E. BROUGHTON

THE ore smelted by the Ducktown Sulphur, Copper & Iron Co., of Isabella, Tenn., contains slightly more zinc than copper and in the semi-pyritic method of smelting in use by this company all this zinc was lost, being carried away as fume and in the slag. The fume produced is a gray to white powder and contains upwards of 40 per cent zinc, chiefly in the form of sulphides, though the oxide and sulphate are also present.

As this fume is an impalpable powder, it is carried along with the gases entering the acid chamber and in the long, slow passage through these chambers it settles out and all the zinc compounds are converted into sulphates. The zinc sulphate, together with what other substances are carried along by the gas, and the lead sulphate formed by the corrosion of the lead chambers combine to form a heavy, white mud which collects in the pan of the chambers and which is quite insoluble in the chamber acid. The mud or sludge thus formed builds up quite rapidly and must be cleared out of the chambers frequently.

With the idea of recovering the zinc values from this mud or sludge, the company began an investigation of the possibility of using an electrolytic process. The first attempts were highly unsatisfactory. The sludge was thoroughly agitated with sufficient water to dissolve out all the zinc sulphate; the agitation was then stopped and the lead sulphate and insoluble substances allowed to settle. The clear solution was decanted and electrolyzed, using insoluble lead anodes and aluminium cathodes. The acidity of this solution ran about 13 per cent sulphuric acid and there were present all sorts of elements more electro-negative than zinc.

After it had been proved that it would be impossible

to electrolyze the solution decanted from the leaching tanks without an initial purification process, a thorough investigation of the problem was begun and a process developed which would yield a practically pure zinc sulphate solution.

An average analysis of the sludge will run as follows:

	Per Cent.
Zinc sulphate ( $\text{ZnSO}_4$ )	51.6
Ferric sulphate ( $\text{Fe}_2(\text{SO}_4)_3$ )	0.1
Sulphuric acid ( $\text{H}_2\text{SO}_4$ )	13.7
Lead sulphate ( $\text{PbSO}_4$ )	14.6
Copper sulphate ( $\text{CuSO}_4$ )	0.4
Cadmium sulphate ( $\text{CdSO}_4$ )	0.6
Moisture	16.0
Residue ( $\text{SiO}_2$ , S, C)	3.0
	100.0

The decant from the leaching tanks will obviously contain all these compounds except the lead sulphate and the residue. The purification process as finally per-

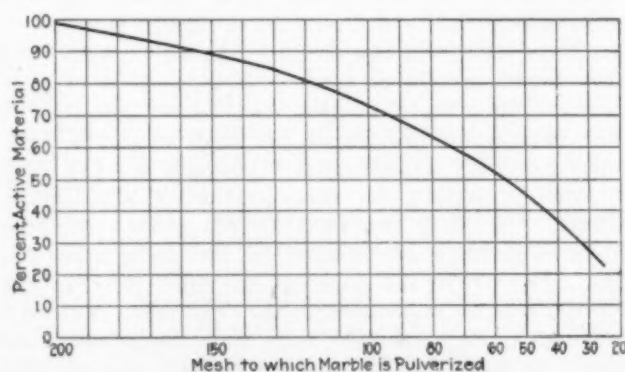


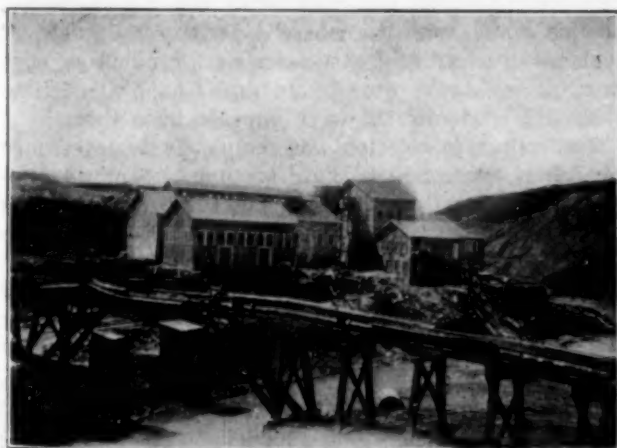
FIG. 1. CURVE SHOWING RELATION BETWEEN FINENESS OF GRINDING AND PERCENTAGE OF MATERIAL ACTIVE IN NEUTRALIZATION

fecting consisted in two main steps: First, the neutralization of the acid and the precipitation of the ferric iron; and second, the elimination of the metals more electro-negative than zinc.

Before taking up the purification process, it might be well to explain the method of handling the marble used in neutralization. From nearby marble works a waste product was procured very cheaply. This marble analyzed:

	Per Cent.
$\text{CaCO}_3$	97.28
$\text{Fe}_2\text{O}_3$	0.17
$\text{Al}_2\text{O}_3$	0.34
$\text{SiO}_2$	1.94
Undetermined	0.27
Total	100.00

This material was in the form of small chips about the size of rice grains and contained no dust. It made an ideal feed to the pulverizing mill and, being bone dry, could be put through very rapidly. The discharge from the mill showed by screen analysis that about 83 per cent would go through a 100 mesh and 100 per



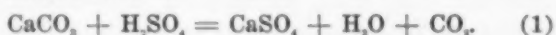
ELECTROLYTIC ZINC PLANT OF THE DUCKTOWN SULPHUR, COPPER & IRON CO., LTD., AT ISABELLA, TENNESSEE

cent through a 30 mesh. The curve in Fig. 1 shows the per cent of active material available for neutralization in this process.

#### PURIFICATION PROCESS

The first step in the purification of the decanted solution was the elimination of the sulphuric acid and the ferric sulphate. This was accomplished in two steps: First, the neutralizing of the acid and the consequent precipitation of the  $\text{Fe}(\text{OH})_3$  from the neutral solution and second, the filtering of the pulp resulting from the first step.

Pulverized marble was used to neutralize the sulphuric acid and was added to the solution in a large mechanically-stirred tank. Steam coils heated the solution to about 60 deg. C., and the action taking place may be expressed as



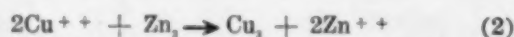
The reaction is complete and the operation simple. As the  $\text{CaCO}_3$  will cease to act as soon as the solution is neutral, there is no danger of carrying the reaction too far and making the solution alkaline. This was a decided advantage, as the zinc would be precipitated even from a slightly alkaline solution.

#### LOSS IN ZINC SMALL

The  $\text{CaSO}_4$  thus formed was fairly insoluble and was easily eliminated on a filter. By a careful washing of the filter cake, the loss in zinc was very small. We have found the Oliver continuous filter to be a most excellent filter for this work, the loss of zinc in the filter cake being less than 5 per cent, while the wash water necessary to accomplish this result was too small to lower materially the concentration of zinc in the filtrate. The only drawback to this process was the frequent cleaning necessitated by the slight precipitation of  $\text{CaSO}_4$  in the pores of the filter cloth as the filtrate cools in passing through. Hot water and stiff brushes, however, applied daily kept the pores nicely open. An occasional bath with hot dilute muriatic acid was found beneficial.

The electro-potential of metallic zinc against a normal solution of its cation (32.5 grams of zinc per liter) is +0.49 volts, and any metallic element which has a lower potential than this under the same conditions of concentration should be replaced in solution by a zinc ion or ions, when the solution containing such metals is brought into contact with metallic zinc. A slightly acid solution accelerates the reaction.

Thus, copper in a copper sulphate solution will be completely eliminated from solution as a spongy deposit on a piece of zinc according to the reaction expressed as



Since any metal capable of forming an insoluble sulphate is automatically eliminated from the solution and left as a residue in the leaching tanks, all the first group and 2B group metals are thus taken care of. This leaves copper, cadmium and bismuth, and the slight amount of iron brought in with the acid used to accelerate the action, to be precipitated on zinc.

The following table gives the electro-potentials of these elements against a normal solution of their cath-

ions and the difference in potential between each element and zinc under the same conditions:

Element	Potential in Volts	Potential of Zinc	Difference in Potential, Volts
Copper.....	-0.61	+0.49	1.10
Cadmium.....	+0.14	+0.49	0.35
Bismuth.....	-0.67	+0.49	1.16
Iron.....	+0.06	+0.49	0.43

These potentials are true only for the pure metal against a pure normal solution of its cation. However, it provides a basis for reasoning, and in actual practice it is found that the reaction does occur quantitatively and quite rapidly.

In the practical application of the principle, the zinc mass must be of large surface and the contact with the solution positive and of as long duration as is practical. The concentration of zinc ions is naturally enormously larger than the concentration of the other metals, and for this reason the actual voltage relations expressed above for ideal conditions probably do not obtain, but sufficient potential difference does exist to procure the desired results.

#### TIME ELEMENT IMPORTANT

It has been found experimentally that, under the conditions imposed by the problem, a concentration of about 0.2 per cent acid gives the best results with the least harm: that is, an average of 0.2 per cent  $\text{H}_2\text{SO}_4$  in the whole process. Now in the practical method of handling this process, the time element is quite important and the amount of acid added to the neutral filtrate from the first step should be proportioned to give an average of 0.2 per cent  $\text{H}_2\text{SO}_4$  throughout the time of contact with the zinc mass. This procedure should be regulated to give a maximum of 0.1 per cent  $\text{H}_2\text{SO}_4$  in the resulting purified solution, or as much less as is practical.

In practice, the above reactions were carried out in two tanks three feet in diameter by seven feet high, operated on the Pachucca principle; the mass of zinc, in the form of broken sheets, nodules and odds and ends from the stripping room, was supported about nine inches above the bottom of the tank on a grating and extended up to within a foot of the top of the tank. A lead pipe extended down through this mass to below the grating. A small air pipe was led down and turned up inside the lead pipe and the air admitted here caused a rapid and thorough circulation of all solution in the tank over the zinc mass. It was feared at first that this method would not work after the zinc mass had become coated with the mossy deposit of the metals it replaced in solution. These fears were groundless, however, as two tanks working in series handled continuously and efficiently the work imposed upon them.

The copper in solution was completely removed in a very short time and the slight amount of bismuth present was also easily eliminated, but the cadmium was a trying proposition, and so far it has been found impossible in these tanks to eliminate it absolutely, no matter how long a time of contact is maintained or what concentration of acid is used.

The precipitated cadmium will redissolve appreciably if allowed to stand in an even faintly acid solution and, since this element is the greatest enemy to a pure zinc product, it was found best to filter all the solution as fast as it left the precipitating tanks, rather than allow the small amounts of solids to settle and then decant a major portion of the solution, as would seem the natural



procedure. The solution from these tanks, after being filtered, was ready for electrolysis.

#### ELECTRODEPOSITION OF ZINC

There is a constant peculiar to each element known as the electro-chemical-equivalent. The derivation of and laws pertaining to these constants are perfectly familiar to the chemical and metallurgical world, and too much profound thought has been given to the subject for this article to add anything further. Suffice it to say that for the element zinc the electro-chemical-equivalent is 1.2211 grams of zinc per ampere hour. Then, theoretically, for every ampere hour of work applied to a suitable solution containing any zinc salt in any concentration, we should recover 1.2211 grams of metallic zinc on the cathode. This constant expressed in pounds of zinc per 1,000 ampere hours is 2.69.

Suppose in the cell we use an average current of 10,000 amperes per day of twenty-four hours, we should expect to recover

$$\frac{10,000 \times 24 \times 2.69}{1000} = 646 \text{ pounds of zinc per day.}$$

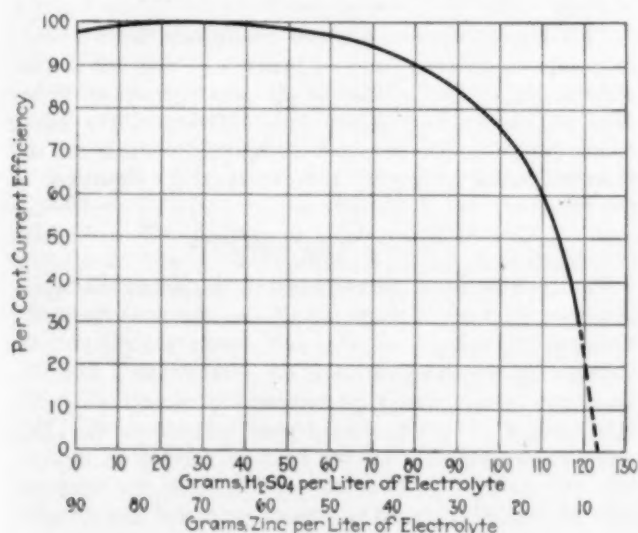


FIG. 2. CURVE REPRESENTING AVERAGE OF A LARGE NUMBER OF POINTS ALL MEASURED UNDER THE SAME CONDITIONS OF TEMPERATURE, CURRENT DENSITY AND ELECTRODES, IN A SOLUTION CONTAINING ONLY ZnSO<sub>4</sub> AND H<sub>2</sub>SO<sub>4</sub>.

If the electrolytic plant operated at 100 per cent current efficiency, this obviously would be the yield. Unfortunately, it is impossible in practice to reach 100 per cent efficiency and a term, "current efficiency," has come into use to express the ratio of zinc produced to the theoretical yield. The curve shown in Fig. 2 indicates the current efficiency of a certain zinc sulphate solution when electrolyzed. This curve will be discussed later.

A solution of any zinc salt forms an electrolyte. The electrical resistance of all electrolytes varies with the salt concentration and with different salts. Thus the electrical resistance of a zinc sulphate solution of, say, 1 N concentration differs from the resistance of a 1 N solution of zinc chloride; and, further, a 1 N solution of sodium sulphate is still different in electrical resistance. Finally, the electrical resistance of a 1 N zinc sulphate solution is quite different from the resistance of a 5 N, or a 1/100 N solution. The laws governing

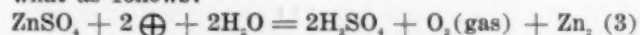
this variation in electrical resistance have been very carefully studied by Ostwald, Kohlrausch and A. A. Noyes.

The researches have shown the existence of certain relations between the concentration of a salt in solution and the electrical resistance of that solution; and further, they have classified the various salts into groups in which the effect on electrical resistance of the solution containing any one member of the group in solution is the same. As a matter of fact, the change in resistance of the electrolyte with the change of salt or concentration is an effect and not a cause.

The cause lies, first, in the fact that it is the individual ion that carries the current through the electrolyte and therefore an increase in concentration will cause an increase in the amount of current carried at a given e.m.f., or a decrease in resistance; and, second, in the speed at which the ion travels through the solution or, as it is called, the speed of migration of the ion. Thus a fast traveling ion will show in solution a greater amount of current transported through the electrolyte (that is, a decrease in resistance) than a slower moving ion if both are present in equivalent concentration.

Since, therefore, the number of ions available and the speed at which each travels determine the electrical resistance of the electrolyte, it is evident that a concentrated solution will be of the lowest resistance provided the per cent ionization of the salt in solution is high. Thus a third factor enters, namely, the per cent ionization of the salt. For a salt may be very soluble, so that its concentration in solution is high, and yet the concentration of ions, or current carriers, may be very low, due to the small per cent of the salt ionized.

When a zinc sulphate solution is electrolyzed the chemical reaction taking place may be expressed somewhat as follows:



While this equation is not strictly true, it serves to express the reaction in a simplified form, indicating the electrical charges of 193,000 coulombs of electricity. If 100 per cent recovery were possible, oxygen gas and metallic zinc would be the only two products of electrolysis. As the acid formed by electrolysis increases, the number of hydrogen ions from the dissociated acid increases, and as the hydrogen ion in solution acts as a metal and therefore travels toward the cathode, some of the hydrogen ions are certain to strike the cathode, give up their electrical charge and be deposited out as hydrogen gas. The amount of hydrogen gas thus formed represents a direct loss, and the current efficiency based on zinc recovery is therefore decreased in direct proportion to the amount of hydrogen involved.

It has been determined that the velocity with which the hydrogen ion migrates toward the cathode, in an electrolyte under an electrolytic pressure of 1 volt, is 0.0032 centimeter per second, while under the same conditions the velocity of the zinc ion is 0.00048 centimeter per second, or the velocity of the hydrogen ion is 6.66 times the velocity of the zinc ion. This difference in speed would mean that one hydrogen ion could travel 6.66 times as far as one zinc ion in a given time, or equally as far as 6.66 zinc ions.

Zinc is a bivalent metal, while hydrogen is univalent;

then from the reaction equation (3), two hydrogen ions are formed every time one zinc ion is plated out of solution (assuming 100 per cent ionization of the acid formed).

Since it is the ionic movement which forms the so-called flow of electrical energy through the solution, it is evident that the greater the number of hydrogen ions in solution the faster will the electrical energy flow through the solution; or, in other words, the lower will be the resistance of the solution.

It is obvious that in the electrolysis of a zinc sulphate solution the  $\text{SO}_4$  ion is unaffected and its concentration therefore will remain constant. Now as the concentration of the hydrogen ion increases, due to the formation of metallic zinc on the cathode by the reaction equation (3), a steadily increasing amount of un-

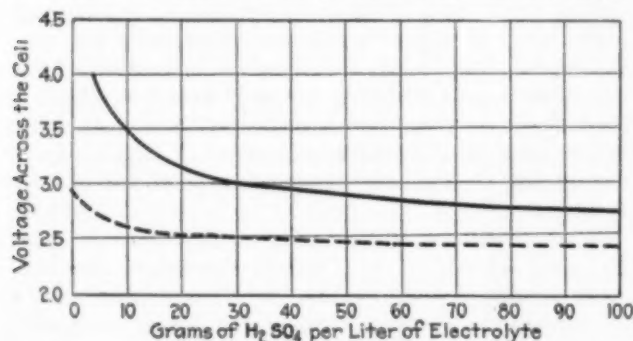


FIG. 3. VARIATION IN VOLTAGE WITH CHANGE IN ACIDITY

dissociated  $\text{H}_2\text{SO}_4$  will be formed and therefore all the hydrogen ions released are not available as energy carriers. The concentration of  $\text{ZnSO}_4$  will directly affect this result, for by the law of mass action  $\frac{(\text{H}_2) \times (\text{SO}_4)}{(\text{H}_2\text{SO}_4)}$  = a constant and due to the high concentration of  $\text{ZnSO}_4$  there will be present a large excess of  $\text{SO}_4$  ions over those required by the hydrogen ions. Or in other words, in order to fulfill the conditions expressed by the law of mass action, a much greater percentage of the hydrogen will be present as undissociated  $\text{H}_2\text{SO}_4$  than if there were no  $\text{ZnSO}_4$  present in the solution.

So the net result in the conductivity of the electrolyte is considerably less than might be anticipated from our study of the relationship between the migration velocities of the hydrogen and zinc ions.

If the zinc sulphate and the sulphuric acid in the electrolyte were completely ionized, however, then the conductivity of the electrolyte would increase rapidly with increase in acidity and more and more hydrogen gas would be plated out as the concentration of the hydrogen ion increased. To carry this result further, when the concentration of hydrogen ion equals 1/6.66, that of the zinc ion, then the number of hydrogen ions coming in contact with the cathode per second would be equal to the number of zinc ions reaching the cathode; and since the current efficiency is the ratio of zinc recovered to zinc theoretically deposited by a given current, this efficiency will be only 50 per cent at this point. Since, however, a varying proportion of the hydrogen ions are suppressed by the high concentration of the  $\text{SO}_4$  ions, this relation is not strictly true in practice.

Based on actual measurements under as nearly per-

fect working conditions as it was possible to obtain, the curve in Fig. 2 represents the relation between acidity of the electrolyte and the current efficiency. It should be noted that the current density at which the points on this curve were measured is 17 amperes per square foot, and the actual current density used in operating the plant varied between this figure and 20 amperes per square foot. The current density is the total current per cathode divided by the area of the cathode exposed to the electrolytic action. This so-called current density is chiefly important as a means of classifying the various effects that the other variables, as, for instance, acidity, impurities, etc., have on the efficiency of recovery; for, as a general rule, the lower the current density under any conditions the higher will be the efficiency. The best working conditions seem to be about 20 amperes per square foot, or a trifle under.

Since for every gram equivalent of zinc plated out, 98/2, or 49, grams of  $\text{H}_2\text{SO}_4$  are formed, it is evident that very nearly one and one-half grams of acid are formed per gram of zinc plated out. Thus, the derivation of the upper scale of abscissa measurement becomes evident.

This curve represents ideal conditions, both chemically and electrically, and in practice it was never possible to obtain better than 70 per cent current efficiency over any given period of time. However, the curve shows what is possible and undoubtedly could be approached more closely by a more careful refinement of the process.

#### VOLTAGE REQUIREMENTS

The electromotive force required to electrolyze a zinc sulphate solution is made up of two factors—first, the dissociation voltage of the salt, and second, the resistance of the path through the electrolyte. The dissociation voltage for zinc sulphate is about 2.35 volts at 15 deg. C. for the concentrated solution used. This value is calculated from the heat of formation in calories per mole of cathion and varies with the temperature of the solution. The errors entering into the calculation due to inexact measurements render the final result rather uncertain, but from a good many measurements the value of 2.35 volts seems to be fairly accurate.

From the above discussion on the variation in conductivity of electrolyte due to change of acidity, it will be seen that since the voltage drop through the solution is equal to the current flowing in amperes multiplied by the resistance of the path in ohms, the potential difference across the electrodes will vary with the acidity of the solution. Therefore the voltage across the electrodes is equal to  $(2.35 + \text{a variable})$  volts. And since this variable reaches its maximum value when the acidity is zero, the voltage across the electrodes should decrease as the electrolysis continues, and this is found to be the case. The accompanying curves in Fig. 3 show the variation in voltage with change in acidity for a certain set of conditions. And while the variation of these conditions would change the numerical value of the ordinates against which this curve is plotted, the general characteristics of the curve would be the same.

The variation in dissociation voltage mentioned above due to temperature change is usually expressed as a

function of the absolute temperature by the ratio  $\frac{\Delta E}{\Delta T}$



where  $\Delta E$  is the change in electromotive force due to a change in the absolute temperature,  $\Delta T$ . The value of this fraction for the range of temperatures permissible in electrolyzing a zinc sulphate solution is

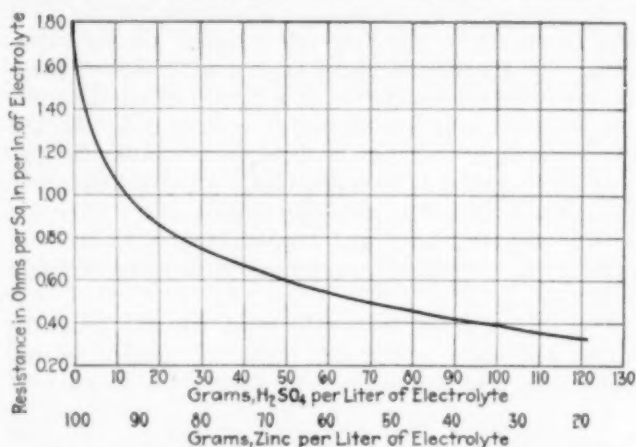


FIG. 4. ELECTRICAL RESISTANCE OF ELECTROLYTE MEASURED BETWEEN C.P. ZINC ELECTRODES

slight, and for all practical purposes the value of 2.35 volts is correct for a pure zinc sulphate solution of 2 N or stronger.

Assuming, then, our dissociation voltage as constant at 2.35 volts, and further assuming that the current flowing through the solution is constant, then the only variable left which can affect the potential difference across the electrodes is the change in the electrical resistance of the electrolyte. Since this change in electrical resistance is directly due to the increase in acidity caused by the electrolytic action as explained above, it is evident that a knowledge of this change of resistance is of considerable importance. The accompanying curve (Fig. 4) shows the decrease in electrical resistance due to a corresponding increase in acidity, as a zinc sulphate solution containing at the start 100 grams of zinc and 0.0 grams of acid per liter of solution was electrolyzed.

By Ohm's law, the potential difference between two points in an electrical circuit is equal to the electrical resistance between these two points multiplied by the current flowing in the circuit. Therefore assuming a constant current of "A" amperes and resistances of "r" ohms from anode to cathode, the potential difference between the anode and the cathode would be  $(2.35 + Ar)$  volts. The dotted curve in Fig. 3 shows the variation of this voltage with increasing acidity. By comparing the theoretical dotted curve with the full line curve based on actual measurements, the similarity in the two is at once evident, although the numerical values for the ordinates are different. This difference in ordinates is due to two facts—first, the solid curve was obtained under actual working conditions while the dotted curve was plotted from data obtained under ideal conditions, and second, the current density in the two was quite different.

#### ENERGY CONSUMED

In buying electrical energy, we pay for the watt-hours consumed, and a watt-hour is the product of the current flowing in amperes times the electromotive force in volts times the time in hours. It is evident, then, that the cost of electrolyzing a zinc sulphate solution is going

to vary only with the variation in voltage, since the current and time are constant qualities; and furthermore that this cost will vary with the acidity of the solution, since this is the factor which causes a variation in voltage. Therefore the higher the acidity of the solution to be electrolyzed the cheaper will be the power costs. Unfortunately, however, the higher the acidity the lower is the current efficiency or the actual amount of zinc recovered. We have, then, a case of two conflicting factors; for with zero acidity we should get 100 per cent current efficiency, but our voltage would be high, while with high acidity our voltage would be low but the yield of zinc would be poor. Obviously there is a zone of best working conditions which it would be well to determine. Assuming a constant current flowing through the solution and our theoretical voltage variation as expressed above, and using the values for the variation in resistance as shown by actual measurements in Fig. 4, we can calculate the power in watts or the energy in watt-hours required to produce a pound of zinc under varying conditions in acidity. Furthermore, from the acid-efficiency curve, Fig. 2, we can pick off the values in percentage yield of zinc under similar conditions of acidity, and by combining these figures we can obtain an expression of the kilowatt-hours required to produce a pound of zinc under varying conditions of acidity in electrolyte. The dotted curve in Fig. 5 represents such a calculation, while the solid curve represents the power required to produce a pound of zinc under actual operating conditions with variation of acidity in the electrolyte. The striking similarity between these two curves is a further proof of the theories advanced.

#### ELECTROLYTIC PRACTICE

While all of the foregoing theories must be kept in mind, in practical electrolytic zinc work there are a

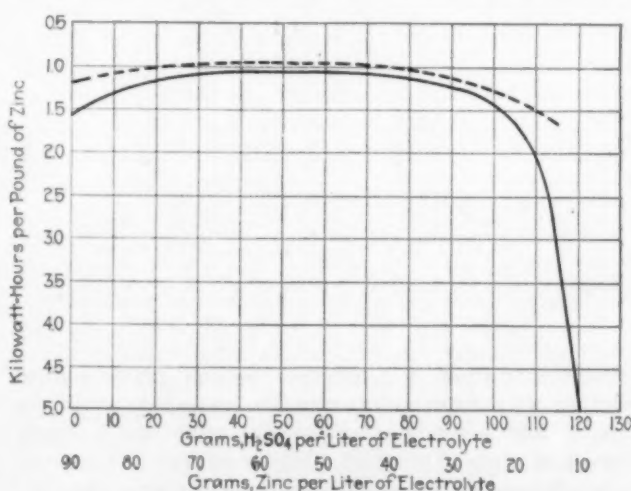


FIG. 5. DOTTED CURVE REPRESENTS THE AVERAGE OF A NUMBER OF POINTS CALCULATED FROM THE DATA OBTAINED AS EXPLAINED IN THE TEXT. SOLID CURVE REPRESENTS ACTUAL MEASUREMENTS AND WITH ALLOWANCE FOR ERRORS IN MEASUREMENT IS ENTIRELY COMPARABLE WITH THE DOTTED CURVE

great many other factors which still further complicate matters. One of the most important of these factors is the effect of impurities in the electrolyte on the deposit and also on the efficiency of recovery. In the first

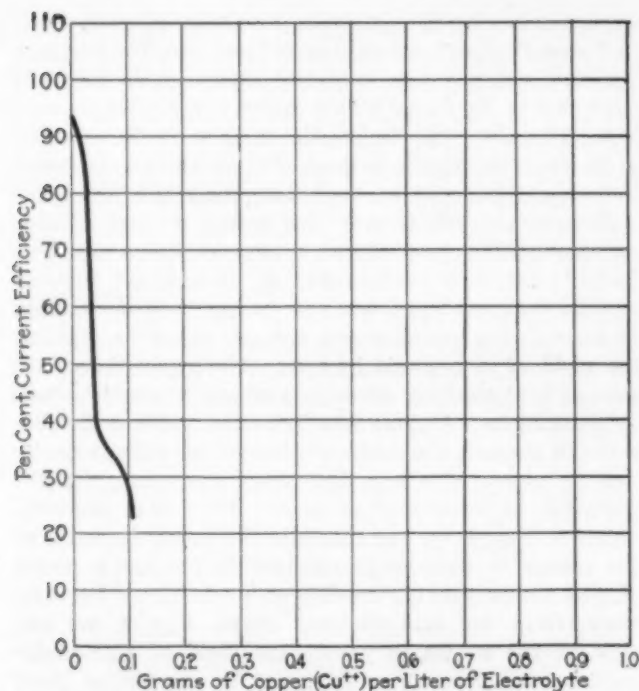


FIG. 6. CURVE SHOWING THE EFFECT OF VARYING AMOUNTS OF COPPER ON THE EFFICIENCY OF RECOVERY

part of this paper dealing with the purification of the electrolyte, the fact was brought out that metals with a lower electro-potential than zinc could be replaced from their solutions by metallic zinc. If this purification process is not carried out to completion, traces of other metals will be found in the electrolyte and, under

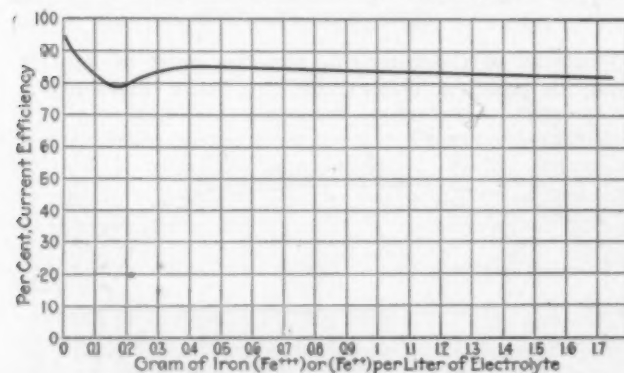


FIG. 7. CURVE SHOWING THE EFFECT OF VARYING AMOUNTS OF IRON IN THE ELECTROLYTE ON THE EFFICIENCY OF RECOVERY

certain conditions, will replace the zinc plated out of solution with astonishing rapidity, eating holes in the deposit and sometimes completely removing a heavy deposit of zinc. The chief offender in this line appears to be copper, as little as 40 milligrams of copper ( $\text{Cu}^{++}$ ) per liter of solution being absolutely fatal to electrolysis. The curves shown in Figs. 6 to 9, inclusive, show the effect on the percentage current efficiency (ratio of actual zinc recovered to theoretical recovery) of varying amounts of the more common contaminating metals. These curves are the results of actual measurements in a solution containing 80 grams of zinc per liter, 2 to 3 per cent acid and varying amounts of the impurities under discussion. The current density in all cases was maintained at 17 amperes per square foot.

The point might be raised that these curves represent only one set of conditions in regard to zinc and acid concentration in the electrolyte. This is quite true; but in the first place, this set of conditions was found to be the best all-round working conditions for the plant and is, therefore, the only set in which we are interested. In the second place, experiments showed these curves to be representative of a family of curves when the zinc and acid concentration were varied. All the curves in each such family were quite similar in contour and varied only by a constant. As would naturally be expected, the efficiencies were always lower when the acidity was increased and the effect of any one impurity was therefore accentuated in a more strongly acid solution.

These curves are true only when the one impurity under discussion is the only impurity present in the electrolyte, and the cumulative effect of a number of

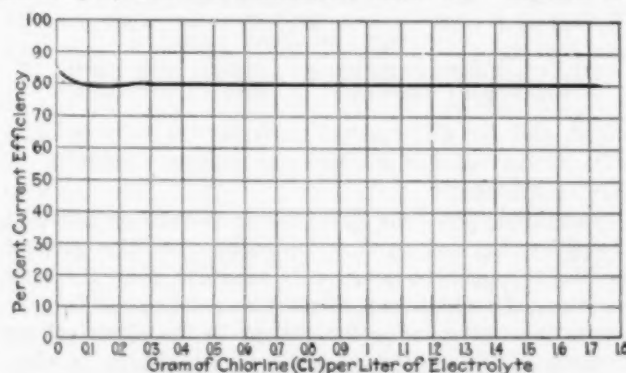


FIG. 8. CURVE SHOWING THE EFFECT OF VARYING AMOUNTS OF CADMIUM ON THE EFFICIENCY OF RECOVERY

these impurities in one solution undergoing electrolysis is naturally greater than any individual case such as we have discussed. This cumulative effect, however, is small through the range of concentration actually met with and the best way in which to determine it is by an actual measurement of the efficiency under the conditions it is desired to investigate.

The curve in Fig. 9 showing the effect of chlorides represents a series of measurements made on a solution containing varying amounts of sodium chloride and is interesting chiefly because it shows that the presence of an anion other than the  $\text{SO}_4$  radical does not ma-

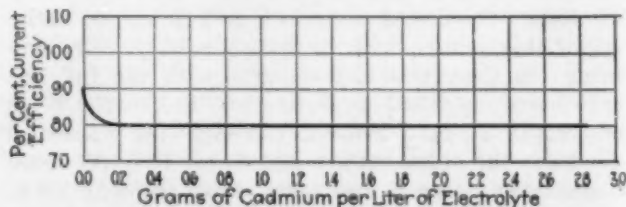


FIG. 9. CURVE SHOWING THE EFFECT OF VARYING AMOUNTS OF  $\text{NaCl}$  IN THE ELECTROLYTE ON EFFICIENCY OF RECOVERY

terially affect the yield of zinc. The chlorides do, however, attack the insoluble lead anodes to an appreciable extent.

There are some impurities which apparently can build up in the electrolyte to a comparatively high concentration without any bad effects. These impurities are practically all above zinc in the electromotive series



and include such metals as chromium, manganese, aluminium, magnesium and the alkalies.

A great deal has been said and written concerning the presence of an alkali sulphate in the electrolyte, some authors claiming a marked improvement in efficiencies with sodium sulphate present, others claiming that even small amounts are detrimental. In the Nahn-sen process for electrolytic refinement of impure zinc anodes, from 100 to 300 grams of sodium sulphate per liter are used. In the author's investigation of the effect of sodium sulphate in the electrolyte on the efficiency, varying amounts were used, but no variation in current efficiency resulted except when a high percentage of acid was present. It is probable, therefore, that the presence of sodium sulphate in the electrolyte merely contributes an increase of  $\text{SO}_4$  ions, thereby causing a corresponding suppression of hydrogen ions and an increase in current efficiency, or yield.

At various times in the history of electrolytic work, not only in zinc but in the electrolytic recovery of all metals, some one operator has discovered and used some simple organic compound in his process which has had decidedly beneficial results. These substances are usually called "additive agents" and probably the most common is ordinary ground glue. The author tried several of these compounds and, while the results were not at all certain, yet there seemed to be less gassing, less heating and a more uniform current distribution when a small amount of glue was kept in the electrolyte circulating system. Excessive amounts were decidedly bad, causing an increase of gassing and a pitting of the surface of the deposited zinc.

At Ducktown the electrolysis was carried out in lead-lined wooden tanks, the lining of each tank being entirely separate from all the others. It was feared at

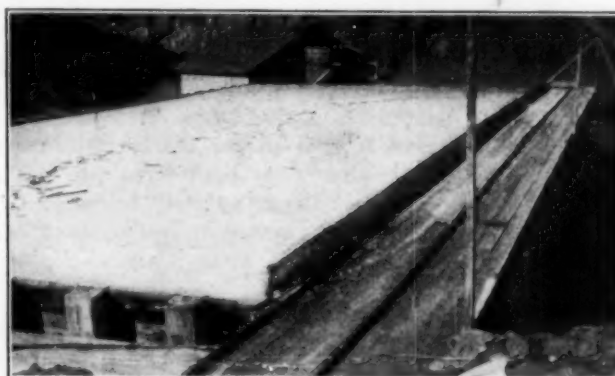


FILLING THE STORAGE TANK WITH SLUDGE FROM THE ACID PLANT CHAMBERS. THE DUMP CAR AND TANK ARE LEAD LINED

first that this construction might cause trouble due to short circuits and ground leaks, but in practice the lead-lined tanks proved very satisfactory. The partition between each two tanks was broad enough to support the equalizing bus bar and the insulators on which one end of the electrodes rested. There were in all thirty tanks or cells in series with ten cathodes and eleven anodes per cell. The voltage across the entire thirty cells was 115 volts, or 3.83 volts per cell. The loss in contact between the electrodes and bus bars was about 0.4 volts

per cell, giving an actual useful voltage of 3.43 volts. The line drop and leakage on the total electrical circuit was about 6 volts. Expressing these figures in percentages, the actual useful voltage was 85 per cent, the contact loss 10 per cent and the line drop loss 5 per cent.

While the cells were connected in series electrically, they were fed individually with solution from a common launder, or we might say the circulating system was a parallel circuit. This circulating system was so arranged as to maintain a constant concentration of zinc and acid in the cells. The way in which this was



STORAGE TANK FULL OF SULPHATE SLUDGE

accomplished was quite simple. A large air lift was installed which was fed from a collecting tank under the floor of the cell room. Across the front of the cells there was built a lead-lined launder; overflow pipes from each cell discharged their solution into this launder; the launders in turn discharged into the collecting tank above referred to. The solution was then pumped by means of the air lift to a distributing tank mounted well above the level of the cells. It was led by means of a lead pipe into a lead-lined distributing launder which in turn fed each individual cell through a small lead pipe. The rate of circulation was about 100 gallons per cell per hour.

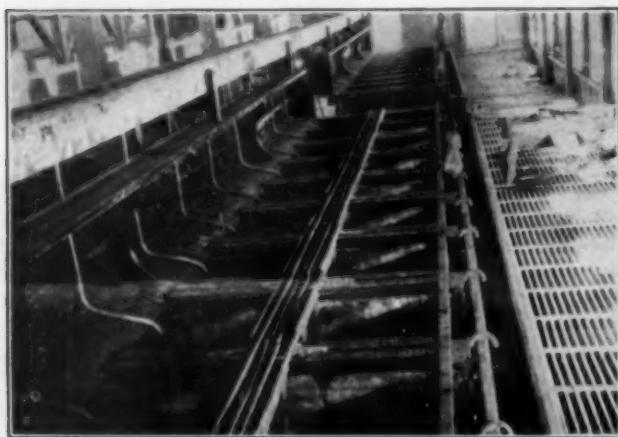
From the lower circulating tank a second and much smaller air lift continually withdrew a small amount of solution. The solution thus withdrawn was returned to the leaching tanks, while at the same time an equal amount of strong neutral solution was added to the circulating system by means of the top circulating tank. The quantity of solution added and withdrawn was so controlled as to maintain a constant concentration of zinc and acid in the cells.

The average analysis of the solution in the cells showed 70 grams of zinc per liter and about 3 per cent acid, and under these conditions of electrolyte the current efficiency averaged 60 per cent.

The only unfortunate feature in this process was the rehandling of so much solution; for in order to neutralize the acid by the calcium carbonate method, the solution had to pass through the Oliver filter a number of times, and in each of these passages some zinc was lost, so that the total loss in zinc in the filtration was high, notwithstanding the fact that each individual passage through the filter showed excellent recovery.

The electrodes used were the usual aluminium cathodes and lead anodes. These electrodes were suspended from aluminium bars, to which they were rigidly

bolted. These bars in turn rested on the aluminium equalizing bus on one end and on a porcelain insulator on the other end. At first the pressure between the aluminium bar and the bus was depended on for electrical contact, but this caused no end of trouble. If one contact became slightly corroded between the surfaces while another contact on the same bus remained good, then the electrode with poor contact would cease to carry any current due to the increased contact resistance, while the electrode with good contact would double its current. Under these conditions the electrode with poor contact would cease to be effective and the zinc deposited on it if a cathode, or by it if an anode, would immediately begin to dissolve in the acid electrolyte, while the electrode carrying double its normal current would become dangerously hot and give off considerable gas. In order to get away from this trouble and insure certain contacts, the aluminium bars from which the electrodes hung were eventually securely bolted to the equalizing bus. A further prevention was the coating of the surfaces of the contacts with vaseline to insure



ONE SIDE OF THE CELL ROOM, SHOWING THE FEED AND OVERFLOW SYSTEMS AND THE METHOD OF HANGING THE ELECTRODES. THERE ARE SHOWN ONLY 3 ANODES AND 2 CATHODES PER CELL

against corrosion. In this way very satisfactory operations were obtained.

Above the surface of the solution during electrolysis there is a great deal of gas and mist, the mist apparently being very fine drops of the electrolyte carried into the air by the gas bubbles rising from the electrodes and bursting at the surface. This mist was very irritating to the mucus membranes of the men working on the cells, and in order to eliminate it the tops of the cells were closed in by a sort of hood which could be raised at will out of the way of the operator. A ventilating fan, connected up with these hoods by means of a system of flues, drew all this mist out of the building and discharged it harmlessly out of doors.

The thirty cells in series were divided into three groups of ten, and a fourth group of ten cells was held as a reserve. The current was led to and from each of these sections through large single-pole switches. These switches were so arranged that any three of the four groups of cells could be connected in series at one time. Furthermore, the fourth group could be cut in and any other group cut out without shutting down the generator. By this means an absolutely continuous operation was maintained, the groups of cells rotating

in order and each group being plated 72 hours. By this method one group of ten cells was cut out each day of twenty-four hours and another group cut in, thus giving a full day to the stripping and cleaning of the cathodes from each group of cells.

The deposit of zinc on the cathodes was usually fairly smooth, a few nodules appearing on the surface and occasionally some treeing, but on the whole a smooth deposit of uniform thickness was obtained. A great deal of trouble was encountered at first with a blistering or bulging of the deposit of zinc. The metal did not appear to cling tightly to the aluminium cathode. This trouble was never completely cured but was relieved very materially by a careful and painstaking cleaning of the aluminium cathodes each time they were stripped.

The zinc recovered was on the whole of very superior quality, the chief impurity being cadmium. The average of a great number of analyses gave 99.90 per cent zinc, with about 0.05 per cent cadmium, 0.03 per cent lead and the rest iron and copper.

The power required to produce a pound of zinc varied from 2.5 to 2.8 kw.-hr.

The sheet of zinc stripped from each side of the cathode will weigh about ten pounds. The stripping of these sheets is a very simple operation; one man can strip both sides of as many as 240 cathodes in ten hours.

In order to market this zinc it must be put in the form of 50-lb. slabs. This means melting all the electrolytic zinc stripped, but as the melting process is a very simple one and almost any type of furnace can be adapted to this purpose, this problem was never a serious one. The zinc in melting down has a tendency to form a spongy mass. Furthermore, while the melting point is about 420 deg. C., the metal must actually be melted at a temperature around 700 deg. C., in order that it may be poured successfully. And at this temperature care must be exercised or the loss by oxidation will be high. It has been found that the addition of a small amount of ammonium chloride to the molten bath has a tendency to break up the sponge zinc and also to minimize the loss by oxidation. The total loss in melting should never exceed 4 per cent of the metal melted, while with large pots or a reverberatory hearth this loss should be materially decreased.

## The Aluminium Bronze Industry

BY W. M. CORSE

METALLIC aluminium has been known for a long time, and its use in copper alloys was discovered about 1855 by Lord Percy. The high cost of production of metallic aluminium retarded its commercial development, and it was not until the discovery of the electrochemical processes for its production that it came to be known as a common metal.

I have been particularly interested, for the past few years, in working with the alloy known as aluminium bronze, which is usually composed of approximately 90 parts of copper and 10 parts of aluminium, by weight. This alloy has many properties similar to the copper-tin bronzes, and it has been of interest to find just where the copper-aluminium bronzes could be sub-

\*Read before the Institute of Metals, A. I. M. E., at Milwaukee, Oct. 9, 1918.



stituted for the copper-tin bronzes, and in that way conserve the use of metallic tin.

Copper-aluminium bronzes have practically double the tensile strength of tin bronzes, so that a smaller cross-section frequently can be adapted, with the same mechanical result. Their resistance to shock is superior to that of the copper-tin bronzes, and their resistance to wear is in some cases superior and in some cases practically equal. Consequently, for many mechanical uses, where a hard bronze is desired to replace one containing 10 to 11 per cent of tin, for example, an aluminium bronze of about the composition mentioned will be found worth investigation. Undoubtedly no two alloys possess exactly the same properties, and when a substitution of one for the other is desirable it is necessary to work out special methods of handling the substitute in order to get practically the same results.

As is frequently the case in such work, special properties are found to be superior to those of the metal originally used and other properties are discovered to be not so good. As a particular instance of the substitution of aluminium bronze for phosphor bronze, I would cite its use in worm gearing. The following table and curves taken from my paper<sup>1</sup> on this subject before the Society of Automotive Engineers will give an idea of the different properties:

TABLE I  
PHYSICAL PROPERTIES OF PHOSPHOR BRONZE  
Composed of 88.7 parts of copper, 11  
parts of tin and 0.3 parts of phosphorus

Ultimate tensile strength, lb. per sq.in.	35,000-40,000
Yield point, lb. per sq.in.	22,000-25,000
Elongation in 2 in., per cent.	6-10
Reduction of area, per cent.	7-9
Specific gravity at 20 deg.	8.5
Brinell hardness number (500 kg. load for 30 sec.)	75-85
Pattern maker's allowance for shrinkage, in. per ft.	0.125
Weight per cu.in., lb.	0.31
Compression, elastic limit, lb. per sq.in.	16,000
Coefficient of friction	0.0040
Modulus of elasticity	12,000,000 to 14,000,000
Resistance to impact, Fremont notched-bar test (fractured section 7 x 10 mm.), kg.-meters	2 to 4
Endurance of alternating impact, Landgraf-Turner or Arnold test, alternations	150 to 400
Resistance to shear by impact, McAdam machine, ft.-lb.	300 to 450

Aluminium bronze containing 10 per cent of aluminium and 1 per cent of iron has the physical properties shown in Table II.

TABLE II  
PHYSICAL PROPERTIES OF ALUMINIUM BRONZE  
Containing 10 per cent of aluminium and 1 per cent of iron

Ultimate tensile strength, lb. per sq.in.	65,000-80,000
Yield point, lb. per sq.in.	23,000-28,000
Elongation in 2 in., per cent.	20-30
Reduction of area, per cent.	21-29
Specific gravity at 20 deg.	7.5
Brinell hardness number (500 kg. load for 30 sec.)	92-100
Pattern maker's allowance for shrinkage, in. per ft.	0.22
Weight per cu.in., lb.	0.27
Compression, elastic limit, lb. per sq.in.	19,000
Coefficient of friction	0.0025
Modulus of elasticity	15,000,000-18,000,000
Resistance to impact, Fremont notched-bar test (fractured section 7 x 10 mm.), kg.-meters	7 to 10
Endurance of alternating impact, Landgraf-Turner or Arnold test, alternations	3500 to 5500
Resistance to shear by impact, McAdam machine, ft.-lb.	750 to 850

It is of interest to note that aluminium bronze would undoubtedly have been substituted for phosphor bronze before this had the manufacturing difficulties with the former been surmounted. Aluminium bronze, when cast in the foundry, presents about as difficult a problem as I have ever seen. It is very sensitive to gas absorption and must be handled extremely carefully to insure good castings. It is similar, from a foundryman's standpoint, to manganese bronze, in that it requires large risers and careful pouring to insure clean castings. Several years' work on this alloy has demonstrated con-

clusively that it is perfectly possible to make as large a percentage of good castings from it as from any other non-ferrous alloy. It seems to me therefore that its use should be increased, particularly in view of the shortage of tin at the present time, and undoubtedly new fields will be opened up as its various properties are better known.

One feature that stands out prominently, which was mentioned by the eminent English investigators of this type of alloys and published by them in the 8th and 9th reports of the Alloys Research Committee of the Institution of Mechanical Engineers of Great Britain, is the fact that cast aluminium bronze possesses properties equal to those of rolled aluminium bronze. Nearly all copper-base alloys are improved by rolling processes, but the copper-aluminium alloys seem to possess equally good properties when cast or rolled; this is a remarkable metallurgical fact. Another important property of these copper-aluminium alloys is their resistance to alternating stress. Many tests indicate that their resistance is greater in this respect than that of some steels, and I have seen instances when cast aluminium-bronze bolts have outlived five steel bolts in foundation work subject to severe shocks. I mention these various instances to indicate that work originally started as research for substitution of one material for another frequently develops an article which has properties not possessed by the original metal or alloy.

I have dwelt particularly on the aluminium bronzes because recently I have done more special work on them than on other alloys, but I believe that the use of aluminium itself in many combinations of metals is a very important subject for investigation. Undoubtedly after the war the cost of aluminium will be reduced from its present price, and considering its low specific gravity it offers a very interesting and important field for research in the non-ferrous business. Naturally, if combinations containing aluminium can be developed, in view of a probable increasing supply of metal the cost will be reduced. This will benefit the industry generally and will immediately conserve tin.

Niagara Falls, N. Y.

## Future of the Barium Industry\*

BY WILLIAM H. ROLLIN

THE future of the barium industry, to my mind, is almost entirely dependent upon whether the Government raises a protecting tariff or not, and it seems to me most appropriate that we should proceed without very much delay so as to get our houses in order against the time when this country will have tremendous competition in those materials which we have made since the beginning of the great war. There are several contributing causes which lead me to think this.

The barium industry in this country is in its infancy and has not had time to become well established or financially strong. The makers of machinery suitable to this industry are lacking in experience and many of their products appear quite crude in comparison with some of the European machinery, and then, for some strange unknown reason, barium products have

\*Read at the Chicago meeting of the American Institute of Chemical Engineers, Jan. 15, 1919.

<sup>1</sup>Journal Society of Automotive Engineers, April, 1918.

always been manufactured on a very small margin of profit and this, in conjunction with the fact that wages in the United States are at least 100 per cent higher than in other countries, would indicate to me that, without the above-mentioned tariff wall to shelter behind, the barium industry will cease to exist in this country in the very near future.

The question of freight rates will also play an important part in determining the future importance of this industry, for we must remember that the consumer can afford to buy our goods only if they are as good in quality and as cheap as the foreign goods.

Now the tendency seems to be for our railroad freights to keep rising and I see very little hope of their being reduced, especially under Government supervision, which, as we all know, is uneconomical and more expensive than private management. On the other hand, the end of the world war leaves the shipping of the world in better shape than it ever was.

#### OCEAN FREIGHT WAR FORESEEN

For the first time in many years the American mercantile marine will enter into the race as a serious competitor against Great Britain, France and Holland. I foresee in the near future an ocean freight war, which will make transportation by water extremely cheap, and if this takes place it will, of course, do its part toward annihilating the barium industry in the country, provided the industry is not given proper protection.

We have information from Europe that the various Governments there are encouraging the consolidation and amalgamation of various interests engaged in the chemical industry, purely with the idea of strengthening their position and their financial condition and putting them in a position to effect great economies in overhead expenses, all with a view toward invading the world's markets with their products and preventing, if possible, the balance of power in the chemical industry from swinging to America.

It is quite obvious that an industry of this kind, which now employs a small army of men, should be maintained and preserved in such fashion that the industry can live, and I would suggest not only tariff protection, but laws which will permit the responsible manufacturers in the same line to meet and discuss freely the costs and selling prices. On the other hand, we, in the United States, are up against the Sherman anti-trust law and numerous other laws of like character, which forbid and make criminal any effort at consolidation or co-ordination of interest and prevent any steps being taken to form the various units of the several branches of the chemical industry into any kind of a league for their self-protection and preservation.

I should, therefore, recommend as a relief and as a protection, that immediate attention be given to our needs by the legislators, and while I do not ask for an excessive tariff at once, I feel that for economic reasons we must have protection, not against Germany alone, but against those other countries which are now ready to compete under a lower wage scale and with cheaper freights.

The system of taxation to which the Government has resorted to meet the expenses incident to the great war, while no doubt very efficient as a medium of obtaining money, is, in my opinion, ill-advised in some respects, in

so far as it seems to bear down with undue weight upon manufacturers in general. This pressure is felt most acutely by such new industries as our own. We find a difference between our Government and the Governments of European countries, who in an endeavor to help and stimulate their growth, in the case of many young industries, declared them to be tax-free until the time that they are financially capable of bearing their proportionate share of the country's expense.

As far as the volume of business is concerned, the barium industry is active or inactive in direct proportion to the business activity or inactivity of the country as a whole.

Barium products, including barium peroxide, barium chloride, barium nitrate, barium carbonate, barium sulphide, etc., depend for their sale on so many diversified interests that the volume of business which can be done in them is a very good index as to the general condition of business throughout the country, and the stoppage or the elimination of the barium industry would have a very deleterious effect on a great many other industries. For instance:

#### BARIUM PRODUCTS USED IN MANY INDUSTRIES

Barium peroxide is used in the times of peace for the manufacture of U.S.P. hydrogen peroxide and as a bleach, especially in the straw hat and blanket industries.

Barium sulphate (precipitated), known in the trade as blanc fixe, is used in the manufacture of automobile tires, in the paper industry, in making printer's ink, in pigments and in many other ways.

Barium sulphide, also known as black ash, is used with zinc sulphate to manufacture lithopone.

Barium carbonate has widely diversified uses in the manufacture of scumless brick, in rat poison and high grade optical glass, etc.

Barium chloride is largely used in the dye industry, is absolutely necessary in the manufacture of photographic materials and enters into the manufacture of a great many other chemical compounds.

Barium hydrate finds its largest use in the beet sugar industry.

Barium nitrate enters into the manufacture of fireworks, detonators, railroad signals and, of course, enters very largely into munition making, as well as having numerous other peace-time uses.

Sodium sulphide, while it can scarcely be talked of strictly as a barium product, is, nevertheless, available as a by-product of the manufacture of certain barium products. It is absolutely essential to the making of sulphur dyes and is the most extensively used depilatory in the conversion of hides into leather.

I have only mentioned a very few of the uses of barium products, but enough, I hope, to allow you to readily see of what importance these uses are and to give you an idea of the necessity of making conditions such that the barium industry will not perish.

To sum up: To put the barium industry on a sound commercial basis in this country we require, first, a strong tariff wall; second, reduced freight rates; third, the right to organize, and fourth, a little more consideration from the Government in the matter of taxes. Given these four items, I would say that the barium industry in the United States has a great future.



## The Manufacture of Hydrocyanic Acid

Compressed Hydrocyanic Acid to Be a Commercial Commodity—Generation of the Gas for Industrial Purposes, Description of Semi-Industrial Apparatus and Plans for a Large-Scale Operation—Yields and Production Capacity

By H. A. PELTON AND M. W. SCHWARZ\*

**H**YDROCYANIC acid was produced for use in the manufacture of cyanogen chloride and for other experimental work. The problem of hydrocyanic acid manufacture may be of interest commercially in connection with the fumigation of fruit trees. At the present time most of the hydrogen cyanide employed for this purpose is prepared on the grounds from cyanide and sulphuric acid, inclosing the trees to be treated in a tent. By employing liquid hydrocyanic acid in cylinders, the trees can be treated with an attendant saving in materials, apparatus and labor accompanied by a more efficient fumigation. It is also possible that hydrogen cyanide may replace carbon monoxide and other gases in fumigating vessels.

### METHOD EMPLOYED

The method employed, in brief, consists in adding sodium cyanide solution to dilute sulphuric acid; the water vapor in the evolved gases is removed by fractional condensation, and the concentrated hydrogen cyanide is then condensed at atmospheric pressure. To expel hydrogen cyanide dissolved in the reaction mixture, the latter must finally be brought to the boiling point. Hydrocyanic acid forms dark tars with excess of sodium cyanide, and the cyanide is therefore added to the acid and an excess of the latter over the theoretical amount is employed. The residual liquor in the apparatus after the completion of the reaction must be promptly discharged, as on cooling sodium sulphate crystallizes out. The apparatus (illustrated in Fig. 1) consisted of a 50-gal. steam-jacketed kettle, lead-lined and provided with a lead-covered agitator. The kettle was fitted with a thermometer well, inlet for cyanide solution, and bottom discharge closed by a lead-lined valve. Vapor leaves the kettle through a column, consisting of a 6-ft. length of 4-in. iron pipe, packed with large lumps of coke; the latter is supported by a perforated

lead plate, placed at the bottom of the column and between the flanges so that it forms a gas-tight metallic gasket.

### APPARATUS EXPLAINED

The reflux condenser is mounted above the column, and consists of about 30 ft. of 1-in. iron pipe, mounted in a half barrel and cooled by ice. Vapor from the column enters the top coil of the reflux; the lower coil leads into a separator, consisting of a tee. Vapor and condensate enter at the top of the tee through a long nipple; vapor leaves through the side opening, and condensate drains from the bottom, and back to the top of the column, through a trap.

The vapor outlet from the separator is piped to the main condenser; the latter is composed of 9 turns of 1-in. iron pipe, 3 feet in diameter. The coil is mounted in a wooden tub, and cooled by cracked ice.

Condensate from the main condenser is received in a sheet-iron cylinder, 12 in. diam. x 24 in. The receiver is mounted in a barrel and provided with a bottom outlet and vent; the latter consists of a vertical length of  $\frac{1}{2}$ -in. pipe, the upper end bearing an inverted U. A sight glass is inserted in the line between the

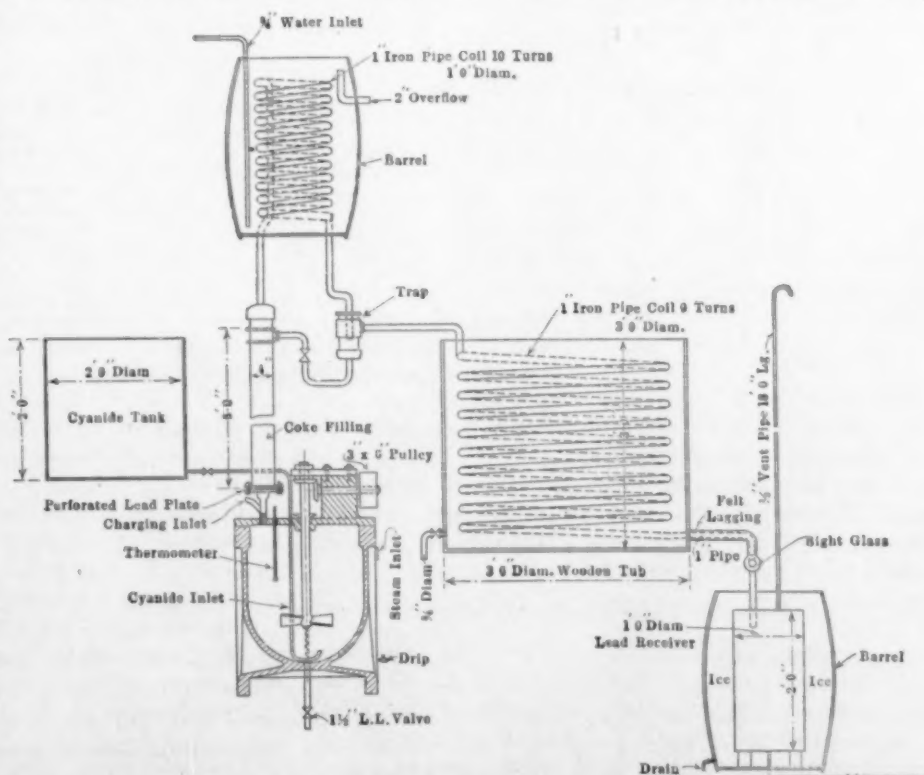


FIG. 1. APPARATUS FOR MANUFACTURE OF HYDROCYANIC ACID

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condenser and receiver. Product is charged in steel cylinder, with valves removed.

The sodium cyanide container is a sheet-iron cylindrical vessel, with bottom outlet piped to the reaction kettle.

#### METHOD OF MANUFACTURE

The kettle is charged with 54 lb. of water and 54 lb. of 66 deg. B. sulphuric acid added, bringing the temperature of the mixture to about 70 deg. C. Forty pounds of sodium cyanide (96 to 98 per cent) are dissolved in 100 lb. of warm water in the sheet-iron container, which is then covered.

The condenser, reflux and receiver are packed in ice, the agitator started and the cyanide solution run into the kettle. The addition should take from 1½ to 1¾ hours. Steam is then turned into the jacket of the kettle, and the mixture brought to the boiling point.

The approximate cost of production is calculated below:

	Cents per lb. of HCN.
Sodium cyanide at 31.5c.....	74.2
Sulphuric acid at 2c.....	6.4
Steam, power, ice, etc. ....	10.0
Labor .....	14.3
Overhead and repairs.....	2.5
	107.4

The charges for power, labor, overhead, etc., can be materially reduced if units of larger capacity are employed.

#### PROPOSED IMPROVED PLANT

Fig. 2 is a drawing of a proposed plant in which various improvements are embodied. Provision has been made for brine cooling and for more accurate temperature control.

As the stability varies with the purity of the product, a bisulphate tower has been introduced for the purpose

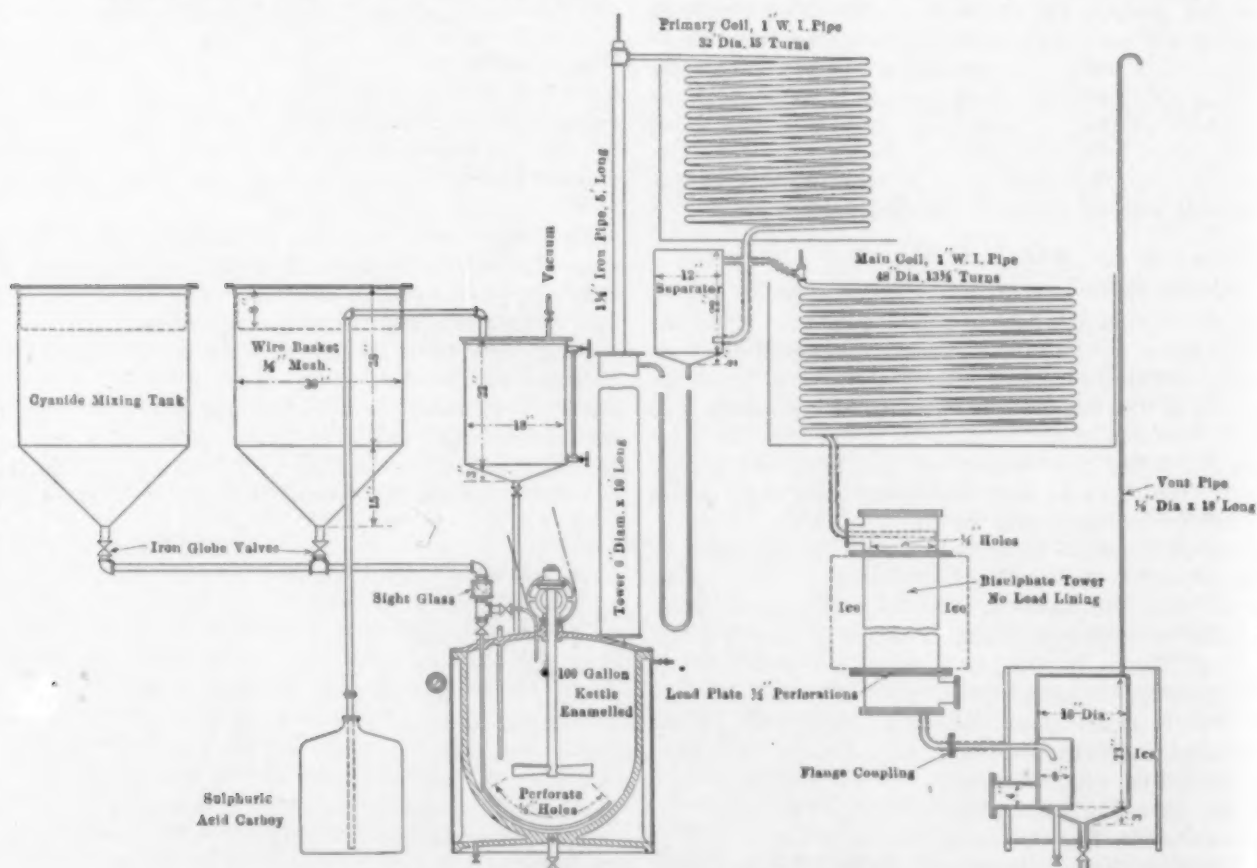


FIG. 2. A PROPOSED HCN APPARATUS

The residue is discharged while warm, and the kettle and discharge lines flushed out.

When the receiver contains a sufficient amount of product, it is drained into an open steel cylinder, previously weighed and cooled. The valve is then inserted, after applying red lead to the thread.

#### YIELDS AND PRODUCTION CAPACITY

An average yield of 78 per cent of the theoretical yield of hydrocyanic acid has been obtained. When the apparatus is properly manipulated the product runs from 90 to 95 per cent HCN. A production of 250 lb. per 24 hours has been obtained by the method herein described, and a total of 7000 lb. manufactured.

of obtaining a more anhydrous product. The receiver is designed to separate any solids carried over from the tower.

In conclusion, the writers wish to express their appreciation of the many helpful suggestions offered by Dr. James R. Withrow, and also wish to thank George O. Kildow for his assistance in the work.

This work was started under the Bureau of Mines of the United States Department of the Interior, and was continued under the Research Division, Chemical Warfare Service.

Small Scale Production Section,  
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## Influence of Temperature Upon the Action of Slag Upon Refractory Materials

BY RAYMOND M. HOWE\*

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**D**URING the present period of intense industrial activity, the linings of the various furnaces have played a very important rôle in determining their capacities. In some cases the firebrick or special shapes have given long continuous service, while in other cases the results have not been as satisfactory. As a result, there has been some contention between the consumers and manufacturers of firebrick as to the relative merits of this product, the consumers often claiming that it is not of the pre-war standard and the manufacturers maintaining that it is of equal quality. The latter maintain that the shorter life of refractories, when encountered, is often due to the more severe duty which is imposed upon their product during the struggle for an ever-increasing output of metals.

The work here presented was carried out for the purpose of determining the action of various slags at different temperatures on several standard brands of firebrick. The data secured would therefore appear to bear directly upon the question at issue, for it is well-known that a common means of increasing production consists of increasing the working temperature.

The general plan was to secure bricks of recognized quality and to test the action of several slags upon them at different temperatures. The method used for determining this action was essentially the same as is used at the Carnegie Steel Co.

Work done at that laboratory has shown that if a brick is heated to a definite temperature and thirty-five grams of slag are placed in a cavity at that temperature and are allowed to act for two hours, valuable information can be secured.

Before adopting their method certain points were checked pertaining chiefly to the influence of the time of action of, and the quantity of slag used, upon the

TABLE I—INFLUENCE OF TIME AND QUANTITY OF SLAG USED UPON RESULTS SECURED FROM SLAG TESTS

Penetration of 35 grams of slag in two hours.....	0.64
Penetration of 35 grams of slag in four hours.....	0.68
Penetration of 35 grams of slag in six hours.....	0.64
Penetration of 105 grams of slag in two hours.....	0.76
Penetration of 105 grams of slag in four hours.....	0.72

results secured. Tests were made in which the time and slag were trebled, but this procedure failed to produce a more pronounced action.

In reporting the results the total cross-section of the slag saturated area was first measured by means of a planimeter. The area of the original cavity was then subtracted from this. The difference represented the area of the section which had been penetrated by the slag. This area when divided by the linear surface of contact gave a value which represented the square inches of penetration per inch of contact.

The results given in Table I confirm those reported by Nesbitt and Bell and lead to the same conclusions, i.e., when a brick having a cavity  $2\frac{1}{2}$  inches in diameter is treated with 35 grams of slag and it is allowed to

react for two hours satisfactory results are obtained. In the preceding work 35 grams of slag reacting for two hours resulted in a penetration value of 0.64. When the severity of this test was increased 600 per cent, the penetration factor increased but 12.5 per cent.

### METHOD OF PROCEDURE

In view of this preliminary work, the following definite method of procedure was adopted:

The test bricks, each having two cavities  $2\frac{1}{2}$  inches in diameter by  $\frac{1}{2}$  inch in depth, were heated slowly to the temperature at which the test was to be made. This temperature was held for  $1\frac{1}{2}$  hours. Thirty-five grams of slag were then introduced and were allowed to react at this temperature for 2 hours. The bricks

TABLE II

Slag	Blast Furnace	Heating Furnace	Basic Open Hearth	Acid Open Hearth	Zinc	Copper
Silica.....	37.32	34.16	18.42	46.48	34.30	28.20
Alumina.....	13.21	6.13	3.85	5.45	14.74	2.20
Iron.....	1.62	43.60	14.55	29.30	21.00	2.10
Lime.....	42.20	1.30	44.10	2.16	2.33	2.51
Manganese.....	2.35	0.65	6.32	0.00	7.07	2.14
Sulphur.....	1.11	0.55	5.09	9.08	6.77	0.00
Phosphorus.....	1.20	0.27	0.42	0.38	5.88	0.14
Copper.....	0.00	0.02	0.58	0.00	0.02	0.24
Zinc.....	0.00	0.00	0.00	0.00	1.28	58.21
Melting point.....	1220°C.	1050°C.	1275°C.	1400°C.	1025°C.	1020°C.

were then allowed to cool, were cut through the center of the cavities, and the penetration was noted in the manner previously described.

Six slags, which were secured from the Carnegie Steel Company's laboratory, were used during the tests. Their analyses and fusion points are given in Table II. The three bricks used are designated by A, B and C.

### EXPERIMENTAL DATA

By following the method already described and varying the brick, the slag and the temperature, one at a time, average results were secured as shown in Tables III to VIII.

In each case the slag penetrated more deeply into the brick at higher temperatures. In several cases an increase of 100 deg. C., or less than 10 per cent, resulted in nearly doubling the penetration.

This increased penetration has several effects in actual practice. One effect concerns the strength of the brick itself. It is a known fact that bricks when saturated with slag are not so strong at high temperatures as when they are free from slag. This decreases their ability to sustain the weight of the other parts of the furnace.

The refractories of the lining is also decreased when it becomes soaked with slag.

The lining is also subjected to more severe chemical action. This action takes place rather slowly in many cases, but rapidly in others. In any event, the action takes place sooner when the slag forces its way further into the inner portions of the lining. Being more active at higher temperatures, its solvent power is also increased.

In view of these tests, it appears very much as if the relation of output and the life of the lining is similar to the rate of driving and the life of an automobile. Cars which operate successfully for 50,000 miles when driven at the rate of twenty miles per hour give much less service when driven forty miles per

\*Paper read before a meeting of the Refractories Manufacturers Association on Nov. 20, 1918.

hour. These same cars when subjected to the gruelling ordeal of a stock car race often fail to complete the first hundred miles.

#### LIVES OF FURNACE LININGS MUST BE COMPARED ACCORDING TO A SLIDING SCALE

Such conditions are constantly encountered when any product is driven to its limit. Such being the case, it is not fair to compare the lives of furnace linings on the daily basis. Neither is it fair to compare them on the tonnage basis, when one furnace is worked at moderate and another at maximum capacity. Under conditions occurring with increased output, they must be compared according to a sliding scale. If a furnace

TABLE III—EFFECT OF VARIOUS TEMPERATURES UPON THE PENETRATING POWER OF HEATING FURNACE SLAG (M. P. 1050°C.)

Brick	Temperature of Test			
	1150°C.	1250°C.	1350°C.	1450°C.
Type A.....	0.04	0.09	0.15	0.34
Type B.....	0.02	0.05	0.11	0.79
Type C.....	0.07	0.10	0.24	0.78

TABLE IV—EFFECT OF VARIOUS TEMPERATURES UPON THE PENETRATING POWER OF BLAST FURNACE SLAG (M.P. 1220°C.)

Brick	Temperature of Test			
	1250°C.	1350°C.	1450°C.	
Type A.....	0.03	0.08	0.14	
Type B.....	0.00	0.11	0.17	
Type C.....	0.07	0.12	0.17	

TABLE V—EFFECT OF VARIOUS TEMPERATURES UPON THE PENETRATING POWER OF ZINC SLAG (M.P. 1025°C.)

Brick	Temperature of Test			
	1150°C.	1250°C.	1350°C.	1450°C.
Type A.....	0.03	0.13	0.28	0.19
Type B.....	0.04	0.16	0.29	0.32
Type C.....	0.05	0.24	0.33	0.43

TABLE VI—EFFECT OF VARIOUS TEMPERATURES UPON THE PENETRATING POWER OF BASIC OPEN HEARTH SLAG (M.P. 1275°C.)

Brick	Temperature of Test	
	1350°C.	1450°C.
Type A.....	0.58	0.73
Type B.....	0.29	0.33
Type C.....	0.44	0.55

TABLE VII—PENETRATION OF ACID OPEN HEARTH SLAG (M.P. 1400°C.) AT 1450°C.

Brick	Penetration
Type A.....	0.24
Type B.....	0.33
Type C.....	0.57

TABLE VIII—PENETRATION OF COPPER SLAG (M.P. 1020°C.) AT TWO TEMPERATURES

Brick	Temperature of Test	
	1150°C.	1250°C.
Type A.....	0.46	0.65
Type B.....	0.36	0.57
Type C.....	0.52	0.62

is operated under such conditions that the daily output of metal is increased 50 per cent, it cannot be expected to last as long, or even two-thirds as long (during which time equal tonnage would have been secured), but from one-third to one-half as long. The consumer must realize this and balance his costs under normal production against those under increased production. If the balance is in favor of conditions of increased production, he must, if he uses the most suitable material, expect to encounter continued shorter service from linings.

**Nitric Acid.**—The records of the War Industries Board show that the production of nitric acid in 1918 was 634,817 tons of 100 per cent nitric acid. The Chemical Division states that no statistics regarding the production in 1916 and 1917 have been gathered.

## Mesothorium Work of the Bureau of Mines

THE demand for radium for medical work, but more particularly for luminous paint, has made the question of possible radium substitutes of considerable importance. Radium luminous paint was used in the war for a number of purposes, more particularly on the dials of instruments used on airplanes, so that these instruments could be read at night; for electric push buttons, door numbers and small images for shrines, etc. The paint is permanently luminous in the dark and contains from 0.1 to 0.25 milligrams radium element to one gram of zinc sulphide. A luminous watch face usually has from ten cents to twenty cents of radium on it.

An excellent substitute for radium for certain purposes is mesothorium. This is a radio-active element found in monazite sand and other thorium minerals. When first extracted it is not in satisfactory condition for luminous paint, but must be allowed to "ripen" for several months or even a year before it can be used. During this time the alpha radiation which is required for luminous paint becomes sufficiently strong. On the other hand the beta and gamma radiation of mesothorium grows rapidly and it can be used for medical purposes within a few days after preparation.

Radium has a long life, half of it decaying in approximately 1600 years. Mesothorium on the other hand has a short life, five or six years being its useful life for luminous paint purposes. The price in the past has varied from 40 to 60 per cent of that of radium, the comparison being on products of equal activity. For medical purposes therefore it cannot compete with radium as long as there is plenty of the latter; for luminous paint, to be used on objects which themselves have a short life, it is an excellent substitute for radium.

Shortly after the United States entered the war the Bureau of Mines made a co-operative agreement with the Welsbach Co. of Gloucester, N. J., for the study of methods of extraction and recovery of mesothorium. The work was carried on at the Rocky Mountain station of the Bureau of Mines at Golden, Colo., under the direction of Dr. R. B. Moore, superintendent of the station, Dr. Herman Schlundt being assigned to the detailed work on the problem. Successful methods of extraction and recovery have been worked out and connected up with the regular metallurgical processes of the Welsbach Co.

The next largest producers of thorium salts in the country about the same time became interested in the recovery of mesothorium and worked out its own methods. Consequently at the present time mesothorium is recovered from practically all the monazite sand treated in the United States.

The details of the work of the Bureau of Mines will be published later. A preliminary announcement was made by Dr. Moore in a paper given at the September meeting of the American Institute of Mining Engineers at Colorado Springs. Incorrect press reports of this announcement gave rise to some serious misstatements of facts, hence this statement.

The Bureau of Mines has never claimed the discovery of mesothorium, as this element was first identified and described by Hahn in 1905.



## Flotation of Oxidized Ores of Lead

Process of Sulphidizing Ores Such as Cerussite, Wulfenite and Cerargyrite — Sulphidizing Agents — Pyrolusite and Other Interfering Elements — Flotation Oils and Results — Consumption of Sodium Sulphide

By GLENN L. ALLEN

IN THE dressing of lead ores a greater recovery of the oxidized minerals is becoming more and more urgent. Concentration of the coarser particles of oxidized minerals of lead usually offers no difficulties not readily met by the time-honored gravity methods, but the recovery of the slime values is often a more difficult problem. Due to its friable nature, the principal oxidized lead mineral, the carbonate, readily finds its way into the slime during crushing and the usual subsequent treatment with jigs and tables. The milling of this carbonate or the mixed carbonate and sulphide ore is therefore almost invariably attended with a serious loss of lead and often of silver in the slime.

In view of the fact that the concentration of the simple sulphide minerals of lead is meeting with success in many flotation mills, it is only natural that the metallurgist should strive to adapt the process to the recovery of slimed oxidized minerals. Gratifying results have been obtained by the use of the ordinary froth-flotation in connection with the sulphidizing process. This is a simple process entailing the use of a small quantity of a commercial chemical, sodium sulphide, or its equivalent.

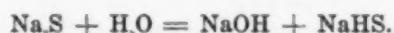
### THE SULPHIDIZING PROCESS

Since the sulphidizing idea is new to many, a brief description of the process, its use, agents and methods may be of value. The process, as applied to lead ores, was tested on a laboratory scale by the Salt Lake City station of the United States Bureau of Mines,<sup>1</sup> to which belongs much credit for directing attention to the possibilities of the process. The writer has since developed and perfected the idea for use on the oxidized lead of the Shattuck-Arizona Copper Co. at Bisbee, Ariz., and the milling data hereinafter given are results of this work.

Sulphidizing is the process of altering oxidized minerals to the sulphide form, at least superficially, to produce a product recoverable by flotation. It consists simply in subjecting the carbonates to be floated to the action of a soluble sulphide such as sodium sulphide. The sulphur molecule of the reagent exhibits a rather remarkable avidity for the lead in the cerussite, and, if the mineral is clean, almost instantly forms a superficial film of lead sulphide on the carbonate particle. This black film is very firm and even exhibits a sub-metallic luster when viewed under the microscope or on the vanning plaque. The amount of sulphidization may vary from a thin film to a complete conversion of the particle. The desired degree of conversion depends on the ore itself and is best

determined by actually sulphidizing the ore and then testing it for flotation. In practice, the amount of reagent supplied to an ore is not necessarily a measure of the degree of sulphidization, because elements other than lead in the ore may destroy the usefulness of the sodium sulphide.

With alkaline sulphides, such as of sodium, another factor limits the amount allowable in practice in the flotation pulp, that factor being the alkalinity due to hydrolysis of the sulphidizing agent. Excess alkalinity produces a very bad physical effect on the flotation, but so far as noticed is not detrimental to sulphidization of lead carbonate ores. In the case of sodium sulphide, hydrolysis is said to be nearly complete:



Thus for every pound of  $\text{Na}_2\text{S}$  dissolved in the flotation pulp, theoretically about half a pound of  $\text{NaOH}$  is introduced. Using increasing amounts of  $\text{Na}_2\text{S}$ , it is evident that a point would soon be reached at which the alkalinity would be detrimental to flotation. This is borne out in practice, and the point at which flotation begins to fail is so marked as to be easily detected by the operator. This maximum allowable alkalinity varies with the pulp conditions, especially with the kind and quality of oil used. For example, when treating 5 per cent lead ore in a pulp containing 30.2 per cent solid and using 1.15 lb. of oil per ton of dry feed, the upper and lower limits of sodium sulphide consumption were found to be respectively 3.5 and 1.3 lb. per ton of dry ore. Below 1.3 lb. the froth was lean in lead—probably due to insufficient sulphidization of the carbonate—while on passing 3.5 lb. the froth flattened, dropped its mineral and broke to water, due to the excess alkali. The mixture of oil used consisted of Cleveland Cliffs wood creosote 25 per cent, crude coal-creosote 64 per cent and Pensacola tar and turpentine No. 350, 11 per cent.

Returning to the hydrolysis equation, it would incidentally appear that the  $\text{HS}^-$  radical is the active sulphidizing agent in this case. In the flotation of cerussite, the chemical action of  $\text{NaOH}$  may even be beneficial, due to the solubility of lead carbonate in  $\text{NaOH}$  solution. The exact chemistry of sulphidizing yet remains to be stated. In keeping with the empiricism of flotation the important fact nevertheless remains that the carbonate, once sulphidized, floats almost if not quite as readily as the natural sulphide.

### SULPHIDIZING AGENTS

Possible agents for use as sulphidizers are elemental sulphur, sulphuretted oils, hydrogen sulphide, various sulphur compounds of sodium and calcium (such as  $\text{CaS}$ ,  $\text{Ca}(\text{SH})_2$ ,  $\text{CaS}_2$ ,  $\text{Na}_2\text{S}$ ,  $\text{NaHS}$ ,  $\text{Na}_2\text{S}_2$ ,  $\text{Na}_2\text{S}_3$ ), and

<sup>1</sup>"Flotation of Oxidized Ores." Ralston and Allen. Circular of the U. S. Bureau of Mines, May, 1916.

similar soluble sulphides of other elements. From the practical and commercial standpoint  $H_2S$  and  $Na_2S$  appear most important at the present time. Both of these are efficient sulphidizers; they are cheap, commercially obtainable, reasonably safe, and not mechanically difficult to handle. Making a comparison,  $H_2S$  is probably cheaper and easier to prepare at the mill, is a narcotic poison and is a more active sulphidizing agent, a property not as desirable as at first might be supposed, especially in treating lead ores. Due to its greater chemical activity, however, it is thought to be better for silver. Sodium sulphide, on the other hand, is obtainable normally in car lots at about 2c. per lb. at the factory for 60 per cent  $Na_2S$ , is convenient and safe to use, has less available sulphur per unit and when used in excess produces undesirable conditions in the flotation pulp. Being less active chemically than  $H_2S$ , it does not so readily attack and sulphidize iron compounds, especially limonite, which so often occurs with lead carbonate. Thus the use of  $Na_2S$  often tends toward cleaner concentrates both in iron and insoluble contents. Sodium sulphide is a depilant, softens the finger nails and its dust is very irritating to the skin and nostrils. It is not dangerous to handle even in quantities if the men are properly protected.

In general, either agent probably could be made satisfactory for most ores through careful adjustment, while the choice of agents would depend on the ore itself and on local conditions. The value of  $Ca(SH)_2$ , and of oils distilled with sulphur for use as reagents, however, is not to be overlooked.

#### METHODS OF SULPHIDIZING

Most lead ores will sulphidize either wet or dry. The use of a gas on dry, finely divided ore, however, does not appeal to the mill man. As most slime subjected to flotation is produced by wet crushing and grinding, the introduction of a soluble sulphide into the mill circuit appears to be the most practical way of sulphidizing. The use of  $H_2S$  gas, however, has been found entirely practicable; for the best results it should be introduced into a thick pulp and the pulp diluted before going to the flotation cells. This procedure eliminates the evil effects of excess  $H_2S$  and insures a more satisfactory sulphidization of the ore.

Wet sulphidizing was practiced exclusively in the mill tests on ore from the Shattuck-Arizona Copper Co., with which this paper deals in particular. The fused sulphide was dissolved and stock solution made up to a definite strength, usually between 3 and 5 per cent  $Na_2S$  by weight. During the course of the experimental work the solution was added successively to the pebble mill grinding the flotation feed (see Fig. 1), to the pebble mill's drag classifier, to the launder leading from the classifier to the dewatering cones, later to the suction of a centrifugal pump elevating the flotation feed to a Saffold agitator just ahead of the flotation cells, and finally to the cells themselves.

As the point of adding the sulphide progressed toward the flotation cells the time of contact between the reagent and the ore necessarily decreased. The time element was at first thought to be an essential

factor, but proved to be relatively unimportant in treating this particular ore. Satisfactory sulphidization was obtained at all periods, as the time of contact between sulphide solution and ore was varied from twenty minutes before entering the flotation cells to zero when adding the solution directly to the head of the cells.

#### INTIMATE MIXING NECESSARY

An essential to sulphidize the ore in hand appeared to be a sufficiently intimate mixing of the dilute sulphidizing solution with the thickened ore pulp, in order to insure a sulphide coat for every particle of carbonate. A sufficient amount of reagent, of course, had to be available in the pulp. It is thought, though, that an appreciable period of time should be allowed for sulphidizing, such being both beneficial and desirable, especially when the limonite content of the ore is relatively high. As the solid in the flotation feed often contained 25 per cent iron, a variable portion of which was limonite and the remainder specularite, it proved a little safer and more satisfactory to add the sulphide to the Saffold machine just before the pulp went to the flotation cells. The Saffold agitator served the double purpose of assisting in sulphidizing the pulp and at the same time thoroughly incorporating the oil. The latter advantage of the use of the preliminary agitator was somewhat more apparent when using more than 1 per cent of oil.

#### SULPHIDIZABLE LEAD MINERALS

Cerussite and wulfenite sulphidize very readily. Minium, anglesite and pyromorphite slowly tarnish to a dull black in strong solutions of  $Na_2S$ , but in practice poor recoveries are made on these minerals by sulphidizing and flotation. Vanadinite and descloizite are very indifferent toward sulphide and therefore float poorly.

Cerargyrite, commonly called horn-silver, often is associated with oxidized lead and fortunately sulphidizes very readily. It is then easily recovered by flotation, concentrates as high as 2000 oz. per ton having been made in small operations. The bromide of silver also sulphidizes readily.

#### INTERFERING ELEMENTS

Certain elements, if present in the ore or associated with the lead in any way, greatly interfere with the sulphidizing operations. Probably the most important of these is manganese—especially in the form of pyrolusite—because of its oxidizing influence on the sodium sulphide. Unfortunately this mineral often is found with oxidized lead ores and is furthermore usually found in the slime portion of the mill pulp. This necessitates a separate treatment for primary and secondary slime or a great dilution of the primary with the secondary slime before satisfactory sulphidizing can take place. The soft, velvety variety of pyrolusite is probably the worst offender. Ralston and Laney of the Salt Lake City station of the U. S. Bureau of Mines have determined that compounds of manganese, basic sulphates of iron and peroxides of lead all destroy sodium sulphide. Ferrous salts in solution are classed as undesirable along with those just mentioned



because they too consume  $\text{Na}_2\text{S}$  in their precipitation as ferrous sulphide. (Sodium sulphide, being the salt of a weak acid, is highly dissociated and therefore precipitates ferrous sulphide.)

#### TYPES OF ORES SUITED TO SULPHIDIZING

As with most other metallurgical processes, no hard and fast rules can be laid down as to which ores are amenable to sulphidizing and flotation. In general, those with silica and iron as the chief gangue constituents in preference to lime and alumina are likely to prove more docile. Even low percentages of manganese are very undesirable, if not prohibitive, as would be any of the other deterrents named above. Kaolinized ores are sometimes rebellious to sulphidizing and flotation, probably more through their physical effect upon the flotation than due to their chemical effect on the reagent.

The Southwest contains several lead deposits in which cerussite is the most apparent mineral, but along with this carbonate occurs variable amounts of lead in the form of pyromorphite, minetite, vanadinite or descloizite. These ores give poor returns by sulphidizing alone, and gravity and flotation usually give undesirable mixtures of little commercial value in the concentrate.

It has been said that ores high in iron would not sulphidize commercially, but such has not proved to be the case. Ores carrying most of their iron in the form of limonite of the yellow ochre variety are usually difficult to handle both from a physical and chemical standpoint.

TABLE I. LACK OF RELATION BETWEEN ANALYSES OF OXIDIZED LEAD ORES, AND THEIR FLOTABILITY

Ore	Au	Ag	Pb	Insol	Fe	S	Mn	$\text{CaO}$	$\text{CuO}$	$\text{Al}_2\text{O}_3$	Zn	Remarks
1	0.02	5.8	23.9	64.7	2.5	0.0	0.0	0.1	...	...	...	Excellent recoveries by sulphidizing.
2	0.02	8.4	10.7	42.6	30.6	Tr.	...	Tr.	...	Tr.	...	Excellent recoveries by sulphidizing.
3	0.14	15.4	34.5	41.2	7.9	1.3	...	1.1	...	...	...	Sulphidizing failed entirely.
4	0.03	102.3	7.6	78.3	5.6	0.0	0.0	...	...	...	...	Excellent recoveries. Very little $\text{CaO}$ and $\text{Al}_2\text{O}_3$ . Silver in form of $\text{AgCl}$ .
5	0.12	0.5	28.3	...	...	...	...	...	...	...	...	Poor results. Ore contained 6.1 per cent V and 8.3 per cent Cu in Cuprodescloizite.
6	0.18	15.9	4.2	73.9	1.1	0.2	0.4	4.7	5.2	4.4	7.0	Poor results by sulphidizing.
7	...	1.3	9.0	60.4	16.3	0.4	...	2.7	1.8	7.6	0.9	Excellent recoveries by sulphidizing.
8	0.01	17.9	16.5	43.3	5.3	3.2	...	3.2	2.3	21.6	5.4	Poor recoveries. Part of the lead in form of sulphide.

The chemical analysis of an ore is of little value in determining its amenability to flotation, unless it discloses interfering elements or suggests unsulphidizable compounds of lead or silver. Table I exhibits the analyses of some ores interesting in this aspect.

#### LEGAL STATUS OF SULPHIDIZING

Sulphidizing, like most other metallurgical ideas, is not new. Commercial application of the idea is now being made by metallurgists who seek to increase the recovery of oxides by flotation. A complete review of

the patent literature on sulphidizing, fully crediting each inventor, has been published by Rickard and Ralston.<sup>1</sup> Reading between the lines of this book it appears that there is no American patent covering sulphidizing with froth-flotation whose validity is not questionable.

#### MILL TEST ON SHATTUCK ORE

About 1000 tons of oxidized lead ore from the mine of the Shattuck-Arizona Copper Co. was concentrated during the sulphidizing tests to be described. The ore occurs in the form of a siliceous breccia, and, naturally, silica is the chief gangue constituent. Iron, mostly in the form of a black, crystallized specularite, together with variable amounts of limonite, is the other most important gangue mineral. Manganese in appreciable quantities has not been detected; lime and alumina occur only in very small amounts, and the sulphur content varies from a trace to 0.4 per cent.

Cerussite, cerargyrite and gold are the valuable minerals. The lead is practically all in the form of the carbonate, but with small amounts of the sulphate present. So far as known at present, the silver occurs in the form of the common chloride. In view of the fact that high recovery of the silver by sulphidizing was difficult to obtain and of the further difficulty of extracting this silver with hypo or cyanide, the writer has suspected at times the presence of some other form of silver.

The gold, silver and lead are apparently in no way associated or combined. The valuable minerals are of considerably greater specific gravity than the gangue, so the mineral particles larger than 200-mesh when free from gangue are readily concentrated by gravity methods. The average daily chemical analysis of the ore was: Au, 0.054 oz. per ton; Ag, 5.86 oz. per ton; Pb, 11.39 per cent; insoluble, 64.12 per cent, and Fe, 12.80 per cent.

#### PRELIMINARY LABORATORY TESTS

Prior to the mill tests, a great many laboratory experiments were made on samples systematically taken throughout the workings in the lead orebody. Each mine sample was dried, crushed and reduced to from —80 to —200 mesh in a disk pulverizer. In a few cases the fine grinding was done in a laboratory-sized ball mill. At first the 500-gram samples used for each test were charged into agitator bottles with solutions of sodium sulphide. This chemical was used in the proportion of 6 to 12 lb. per ton of ore treated.

As the experimental work progressed the preliminary treatment was discontinued and the sulphidizing accomplished directly in the flotation cell. The dry, pulverized ore was placed in the cell with sufficient weak sulphide solution, and water added to make a pulp of 50 per cent solid. One minute of sulphidizing agitation was given before adding the oil for emulsification. After oiling the sulphidized pulp, the test machine was filled with sufficient water to make a pulp of about 25 per cent solid and the test completed in the regular manner, making both the roughing and cleaning operations on the same sample. A Janney test machine was used in the laboratory work.

<sup>1</sup>"Flotation," Rickard and Ralston, p. 360.





was next added to the spigot discharge of the settling cones. With some readjustment of oils, pulp densities and a decided reduction in the amount of  $\text{Na}_2\text{S}$ , the flotation cells continue to give a good account of themselves.

Sodium sulphide solution was added to the inlet of the Saffold agitator with satisfactory results and finally carried down the flow sheet and added directly to the flotation cells. Although good results were obtained here, the cells required somewhat closer attention and their work appeared to turn on rather fine points as to alkalinity, oils, pulp density, etc. It was evident that more consistent results could be obtained by adding the sulphide to the discharge of the Callow cones, thus allowing a few minutes' contact and insuring a thorough mixing of the pulp with the weak sulphidizing solution before reaching the flotation cells. This arrangement permitted the sulphidizing reaction to occur before the oil was added to the pulp. Such would seem to be the logical sequence, but satisfactory flotation was obtained consistently while the sulphide and oil were added simultaneously to the Saffold machine.

#### FLOTATION OILS

The oils used in flotation were for the most part mixtures of hardwood and coal creosotes with small amounts of pine or pine-tar oils in addition. With frothing creosotes no pine oil was needed. While some oils and oil mixtures did better work than others, the choice of oils was not a critical part of the process. Once the sulphidizing and flotation practice was established with experienced operators, quite a variety of oils could be used with very similar metallurgical results. An oil mixture on which much of the work was done consisted of Cleveland Cliffs wood creosote No. 1, 25 per cent; Barret creosote No. 609, 64 per cent; and Pensacola Tar & Turpentine Co. No. 350, 11 per cent. About 1.2 lb. of the mixture was used per ton of dry ore in the flotation feed. Even coal tar and fuel oil were included in some of the mixtures with satisfactory results. Good results were obtained by the use of from 17 to 20 lb. of oil of the following composition:

	Per Cent
California fuel oil.....	79.2
Barrett creosote No. 609.....	9.4
Cleveland Cliffs creosote No. 1.....	5.7
General Naval Stores C-15.....	5.7

Many other oils and combinations of oils would no doubt have given just as good results. With most oils a large flow of sulphidizing solution called for more oil, and conversely over-oiling could be remedied by increasing the flow of sulphide.

#### MILL RESULTS

About 30 tons of ore were treated per day at the rate of 130 to 150 tons per 24 hours. The rate of treatment was limited for the most part by the pebble mill's ability to grind the tailings from the primary tables. The concentrator operated one shift of 8 hours per day, but considerable time was consumed in making repairs and changes incidental to experimental work and in starting and stopping the mill. The daily sampling, both automatic and hand, was not begun until all adjustments had been made and the machines ap-

peared to be doing their best under the conditions imposed on them for the particular test in hand.

The average of the daily work of the general concentrator under a variety of conditions tested in a month is exhibited in Table II. Table III gives the results of a typical day's work but on a rather high-grade head. The concentration ratios and the percentage weights were calculated on the lead assays because the gold and silver values were difficult to sample and assay accurately.

#### WORK OF PRIMARY TABLES

The Butchart primary tables gave a very satisfactory performance both in point of recovery and capacity. A single table satisfactorily handled 150 tons of -5 mm. feed per 24 hours, recovering 55 to 70 per cent of the total lead and about 45 per cent of the silver in its feed. This was crushed by rolls to pass a 5-mm. round-hole trommel and was neither deslimed nor classified before going to the table. From 8 to 16 per cent of the primary table feed was -200 mesh. The tables were equipped with Butchart progressive pitch riffles  $\frac{1}{8}$  in. deep at the feed-end, sloping to  $\frac{1}{16}$  in. at the concentrate discharge end. The tables were set for a  $\frac{3}{8}$ -in. stroke and made 275 strokes per minute. The average work of the primary tables is exhibited in Table II.

#### WORK OF THE SECONDARY TABLES

The secondary or fine-sand tables accounted for 9.1 per cent of the total lead in the original ore delivered for a month to the head of the mill, and 80 per cent of the gold, 47.5 per cent of the silver, and 71.6 per cent of the lead in their own feed. They handled from 40 to 60 tons of fine, deslimed sand per 24 hours, the spigot product of a hydraulic classifier. The average feed to these tables for a month contained 0.05 oz. Au, 4.9 oz. Ag, 4.38 per cent lead, 78.4 per cent insoluble and 9.6 per cent Fe. From 5 to 8 per cent of this feed was -200-mesh slime which should have been removed by the desliming classifier. The tables did good work on the fine sand but of course did not recover anything from the -200-mesh slime.

The table middling, containing about 0.05 oz. Au, 5 oz. Ag, 4 per cent Pb, 68 per cent insoluble and 17 per cent Fe, was returned to the Hardinge mill.

The greatest silver loss on the secondary tables was in the +48- and +65-mesh sizes, indicating that finer grinding might free more silver and thus help the recovery. The average daily work of these tables is shown in Table II.

#### FLOTATION RESULTS

Flotation recovered about 20 per cent of the total Au, 6 per cent of the Ag, 15 per cent of the Pb, and 8 per cent of the iron in the original ore as delivered to the mill. The flotation section was equipped with two K. & K. machines with 8-ft. x 28-in. and 10-ft. x 28-in. rotors respectively, and during the latter part of the experimental work with a special cleaning cell with a 4-ft. x 12-in. rotor. The two large machines in series satisfactorily handled 127 tons of dry feed per 24 hours and averaged about 50 tons with an attendant recovery of 84.5 per cent of the Pb, 41 per cent of the Ag with 77 per cent of the Au in their own feed.





One 10-ft. machine alone handled 50 tons in several tests but the tails consistently assayed a few tenths per cent of lead higher than when two machines were running in series. Even with a large reduction in tonnage one 10-ft. machine alone would not produce as low a tail.

The 4-ft. cleaning machine appeared to raise the grade of the combined concentrates from the two roughing machines about 10 points without affecting the tailing loss of the second machine in the series. The concentrate from the first rougher in series was usually sufficiently high-grade so that it did not require cleaning. In most of the tests only the froth from the second machine in the series was retreated in the cleaner.

The feed to the flotation machines was 97 per cent -200 mesh. It contained between 4 and 5 per cent of Pb, 2 to 3 oz. Ag per ton, 16 to 21 per cent of Fe and about 62 per cent insoluble. About half of this silver was recovered and no more silver was recovered after a strong sulphidizing treatment than after a weak one. Just why a higher recovery of the silver by flotation was not obtainable has not been determined. Senn vanners and slime tables failed to make any further recovery of either silver or lead from the flotation tail.

The finished flotation concentrate under the best conditions was quite clean. One day's work, for example, assayed 0.10 oz. Au, 10.2 oz. Ag, 65.1 per cent Pb, 3.5 per cent insoluble and 5.9 per cent Fe. Especially during the early part of the testing no special effort was made to obtain high-grade concentrate from the flotation cells. The daily average of all tests made during one month is shown in Table II. This average, of course, includes many days on which unfavorable conditions were imposed on flotation purely as a matter of experiment. Table IV shows the work of flotation under different conditions.

In one test an attempt was made to slime the entire tail of the primary tables by two-stage grinding in two 8-ft. x 36-in. Hardinge mills. The use of the secondary tables was discontinued. Their usual feed was reground and sulphidized in the second mill, then discharged directly into the first flotation machine in the series along with the primary slime and that produced by the first Hardinge mill. The discharge of the second mill contained 6.3 per cent +65 mesh and 54.3 per cent -150 mesh. The results of flotation for the day are shown in Test 5, Table IV.

#### CHEMICAL CONSUMPTION

The usual consumption of 100 per cent  $\text{Na}_2\text{S}$  per ton of dry slime treated by flotation was about 2.6 lb., ranging from 1.5 to 15 lb. With 4.5 per cent lead ore, 2 lb. usually gave good results. In terms of the commercial 60 per cent  $\text{Na}_2\text{S}$  this would be equivalent to 3.3 lb., costing about 10c. with cheap sulphide, or about 17c. with sulphide at war prices. Sodium sulphide sells in normal times for about \$1.85 per 100 lb. of 60 per cent  $\text{Na}_2\text{S}$  f.o.b. factories in the East. At present, from \$3.00 to \$3.50 per 100 lb. in car lots is asked in New York and on the Pacific Coast. Thus the cost of sulphidizing need not exceed 17c. per ton even under unfavorable conditions. The manufacture

of  $\text{Na}_2\text{S}$  at the mill is not at all impossible under favorable conditions, but in this respect  $\text{H}_2\text{S}$  probably has the advantage.

Rapid and accurate analytical methods based on iodometry have been developed for the control of sodium sulphide solutions. A cheaper means of control is afforded by the use of hydrometers, following the practice of alkali manufacturers.

For each pound of lead carbonate recovered about 0.02 lb.  $\text{Na}_2\text{S}$  was consumed. Theoretically 0.29 lb.  $\text{Na}_2\text{S}$  is required to convert completely one pound of lead in the form of carbonate to the sulphide  $\text{PbS}$ . At the rate of 2.6 lb.  $\text{Na}_2\text{S}$  per ton of 5.92 per cent lead ore with 84.8 per cent recovery, it may be calculated that only 6.9 per cent of the theoretical  $\text{Na}_2\text{S}$  suffices for sulphidizing for flotation on a favorable ore. It is obvious that the sulphide coating produced on the carbonate particle must be very superficial under the conditions just given, which were those obtaining in the test mill. Even with its very thin coating of sulphide the carbonate was a brilliant blue-black. The concentrate coming from the flotation machines appeared much the same as a rich galena concentrate. The black appearance of the froth changed to a dull maroon color when the ore in the pulp contained much iron, but the grade of the concentrate remained much the same. About 99 per cent of the concentrate from the flotation cells was -200 mesh. Operation of the cells was easier and low tails were more consistently obtained on feed consisting of all -200-mesh material than on pulp containing mixed sand and slime.

#### FUTURE OF THE PROCESS

Sulphidizing is not offered here as a panacea for all lead carbonate troubles. On the contrary it has failed almost completely in some instances, due either to elements interfering with the sulphidizing, to difficulties inherent to flotation, or to both.

For ores consuming or destroying relatively large amounts of chemicals, cheap reagents must be had if the process is to be commercial. The manufacture of  $\text{H}_2\text{S}$  from oil and sulphur is a step in this direction. Other methods for the production of sulphidizing agents are being investigated. Combinations of reagents offer possible advantages in some instances and sulphidizing in combination with leaching and precipitation methods offers possibilities.

Although doctors disagree as to the probable application that sulphidizing will have in ore dressing, one thing is certain—the last word has not been said.

Shattuck-Arizona Copper Company,  
Bisbee, Arizona.

A waterproof coating for airplane propellers, which incorporates thin aluminium leaf in the finish, was developed by the Forest Products Laboratory at Madison, Wisconsin, and placed in production by the War Department. The process is practically 100 per cent effective in preventing absorption of water, particularly in the storage stage. A French authority states that 80 per cent of the French propellers produced are rejected by the pilots mainly because they are out of balance. This difficulty is due largely to unequal absorption or distribution of moisture and can be greatly reduced by an effective waterproofing coating.

## Fuel Economy in the Boiler House—I

Study and Importance of the Heat Losses in Boiler Plants and Their Control—Automatic Flue Gas Recorders and Details Regarding Gas Sample Conduits, Tubes, Stopcocks, Soot Filters and Water-Jet Pumps

By JOHN B. C. KERSHAW

THE call for efficiency in the working of steam boilers was never more urgent than at the present time, when the outlay upon fuel forms such an important item of manufacturing costs in all our staple industries. Whatever the basis of the political settlement may be, the end of the war will not mean a return to the status quo ante with regard to fuel, and it is in the highest degree improbable that coal mined in Europe and America will ever return to its pre-war low level of value.

The subject of fuel economy will therefore not cease to be of importance when the war ends, but will remain equally urgent in the strenuous years of industrial competition that are ahead. Power users, consequently, both on grounds of personal profit and public interest, ought to study the question of fuel economy in the boiler house, for it is here that the greatest waste of fuel is occurring in connection with manufacturing industries.

### HEAT LOSSES IN THE BOILER PLANT AND THEIR CONTROL

Figs. 1 and 2 are curve diagrams, showing the various heat losses in two typical boiler plants, both burning the same fuel—a bituminous slack testing 13,500 B.t.u.—one badly managed and the other well managed. From these diagrams it can be seen that the heat units carried away by the waste gases account for the larger proportion of the loss in both cases and that the best chance for reducing this loss lies in the strict control of the temperature and volume of these escaping gases.

The importance of the regular testing of the waste gases passing away from boiler plants lies in the fact that only by chemical tests can one judge of the dilution of the gases and whether a great excess of air is being

even trebled. Efficiencies of 70 per cent and over can be attained in the boiler plant only when the heat losses in the waste gases have been reduced to a minimum (1) by cutting down their volume and (2) by reducing their temperature to the lowest point compatible with the maintenance of the required draught at the base of the chimney.

As regards the percentage of heat that may be quite easily lost with the gases escaping to the chimney with varying percentages of carbon dioxide, the following table is instructive:

Percentage of CO <sub>2</sub> in Waste Gases	Percentage of Heat Lost		
	400 Deg. F.	500 Deg. F.	600 Deg. F.
4	32.40	40.50	48.60
6	21.80	27.30	32.80
8	16.40	20.80	24.90
10	13.40	16.80	20.20

The losses range, therefore, from 13.4 per cent of the total heat (which may be regarded as the minimum possible when natural draught is used) up to 48.6 per cent, or nearly one-half the heat produced by combustion of the coal.

It may be objected that the latter limit is seldom reached in practice. The writer has made many tests upon boilers worked without scientific control, the exit gases from which showed only 4, 5 and 6 per cent CO<sub>2</sub>, and he is convinced that heat losses to the chimney equivalent to one-third of the fuel burned in the boiler furnaces are quite common in practice. The scientific control of boilers, therefore, demands regular and systematic examination of the waste gases.

### AUTOMATIC CO<sub>2</sub> RECORDERS

It is now about fifteen years since automatic CO<sub>2</sub> recorders first made their appearance. For a time they

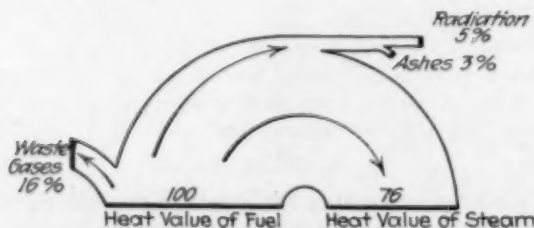


FIG. 1. EFFICIENCY DIAGRAM FOR A WELL MANAGED BOILER PLANT

passed through the furnaces. If no tests are made, the engineer in charge of the plant is absolutely in the dark as to the course of the combustion process. The waste gases, however, carry with them to the chimney a large proportion of the heat energy of the original fuel, and if the volume of these gases be unnecessarily increased, the proportion of heat lost in this way is doubled or

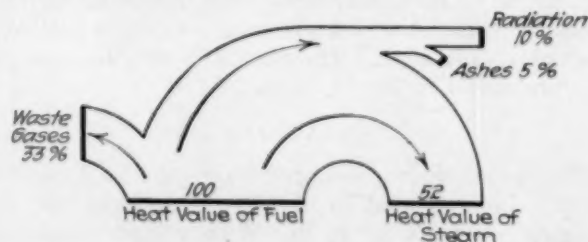


FIG. 2. EFFICIENCY DIAGRAM FOR A BADLY MANAGED BOILER PLANT

enjoyed great popularity, and were to be found in all boiler houses where the engineers prided themselves on being alive and up to date. The difficulties met with in keeping the apparatus in good working order, however, were considerable, and as the recorders failed to satisfy the demands made upon them, they were discarded by many engineers who at first were most loud in



their praise. Their failure was due not so much to defects in the apparatus, though no doubt some of them were unnecessarily complicated, as to defects in their installation and in their methods of use.

In the first place, the pipe connections between the automatic gas-testing apparatus and the boiler flues were made too long and had too many joints, with the result that air leakage occurred and in some cases the pipes corroded up. Another common cause of failure was the blocking of the filter used to remove the soot and moisture from the gases before they were tested; but the most general cause of failure was the placing of the apparatus in charge of an engineer or stoker who had had no previous training or experience in the care of delicate mechanism or glass apparatus.

#### THE CAUSES OF TROUBLE

To deal with these causes of trouble in order, the connecting pipe from the recorder to the individual boiler flues should never exceed 30 ft. in length and should be constructed, not of iron or lead, but of 6-ft. lengths of glass tubing,  $\frac{1}{2}$  inch in external diameter, joined to-

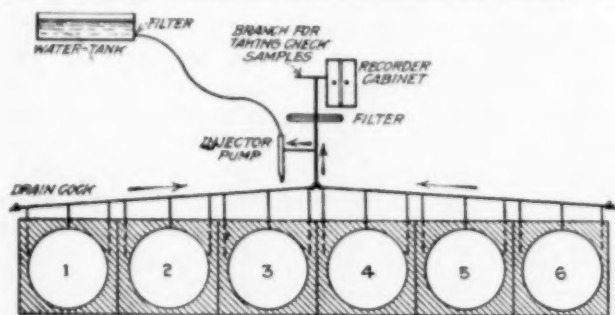


FIG. 3. DIAGRAM OF GAS CONNECTIONS FOR A BATTERY OF SIX LANCASHIRE BOILERS

gether with couplings of the best red rubber, wired on. An engineer would, of course, specify metal tubing with screwed joints for this purpose, but as a chemist with some practical knowledge of the subject of gas sampling and testing under works conditions, the writer believes firmly in the advantages offered by glass over metal. In the first place it is non-corrodible and in the second place one can see when cleaning out is required, whereas with metal tubes one is absolutely in the dark as to the state of the interior. Gas-testing apparatus ought, therefore, always so far as possible to be constructed of glass, for the two advantages of non-corrodibility and transparency far outweigh all the disadvantages attached to the use of a fragile material, and with care, glass apparatus and tubing can be used for years without renewals of any kind, except at the joints. These joints will require attention, but if good rubber be used they will last six months or more, through they should be renewed at once when the rubber begins to crack.

#### TUBES AND STOPCOCKS

At each branch to the boiler, or to the main flue, a glass stopcock and T piece must be inserted in the line, with the longer leg pointing vertically downward. The tube that actually passes into the flue is attached to this leg, and must be of  $\frac{3}{4}$ -in. external diameter hard "pot-ash" glass in order to withstand temperatures up to

800 deg. F. without softening or melting. These dependent tubes, where they pass through the brickwork of the boiler setting, should be protected by flanged iron guard tubes  $\frac{3}{4}$  in. or 1 in. diameter, and should be fixed firmly in these with the aid of cork bungs. The glass stopcocks must be regularly cleaned and greased, and once a week the tightness of the whole system of connecting tubes must be tested by closing all the stopcocks and working the water-jet air pump until a vacuum of 8 in., as registered by a gage connected to the line near the pump, is attained. Should this be impossible, the leakage that destroys the vacuum must be sought for and stopped. At frequent intervals the dependent tubes that pass into the flues, also the main length of connecting tube, must be freed from internal soot and dust by the aid of low-pressure steam or by flushing with warm water, the hard glass tubes being withdrawn from the flues and cooled before this treatment is carried out.

#### ONE RECORDER TO SIX BOILERS

It is advisable to have a recorder installed for every six boilers and to be able to connect this as desired to the flue from either the right or left hand boiler fire (in the case of Lancashire boilers) and to the main flue behind each boiler. (See Fig. 3.) This gives a maximum of eighteen connections on any one line. The cabin or cupboard in which the apparatus is installed should be placed centrally, so that three of the boilers are on one side of it and three on the other. The tubes should be laid with a fall away from the central connection to the recorder, in order that the moisture that condenses in the line may be removed at frequent intervals of time by opening the end stopcock of each branch.

#### DESIGN OF SOOT FILTER AND WATER-JET PUMP

The soot filter may be constructed of sheet lead (although a glass one constructed on the laboratory "desiccator" principle would be better) and should be placed close to the recorder, so that there is only one filter on each connecting line, and this can then be kept under constant observation. It must be of the circular flat shallow type, which gives a large filtration area with a small cubical capacity, in order that there may be less "lag" in the test records. The joint between the two halves of the filter is made with a rubber gasketing and two external rings of hard lead or iron, provided with bolts and thumbscrews. Glass-wool or asbestos-felt supported on wire gauze is used as the filtering medium; this must be removed and renewed daily or oftener, according to the amount of soot contained in the waste gases. The advantage of placing the filter close to the recorder is that only the gas actually tested is passed through it, whereas if it be placed upon the main connecting line all the gas withdrawn by the pump from the flues will pass through it and it will require cleaning much more frequently.

When an ejector type of water pump is used to abstract the gas from the flues it is advisable to provide a separate water supply tank, fitted with a filtering attachment to retain fine particles of grit and other matter which might stop up the jet of the air pump and cause it to cease working. A steady pressure or head of water is also required in order to obtain satisfactory operation with this type of pump; this is most

<sup>1</sup>See "Sampling and Analyzing Flue Gases," by H. Kreislinger and P. K. Ovitis, Bureau of Mines Bull. 97 (1915).

easily arranged for by installing a separate supply cistern with a floating ball-tap and lead run-off pipe.

Automatic and continuous CO<sub>2</sub> recording apparatus falls into two broad classes, according as the percentage of carbon dioxide gas is measured by direct absorption in caustic potash or some physical characteristic of the gas that is a criterion of the CO<sub>2</sub> contents is observed and measured. In the article following, descriptions and illustrations of all the well-known types will be given. In closing this introductory article, however, it is well to emphasize the great importance of regular and systematic chemical examination of the waste gases in boiler plants, and to urge that the care of any automatic testing instruments installed should be placed in the hands of specially trained men, and not left to the charge of ordinary stokers or shift-engineers who may happen to have a few spare minutes available or may volunteer for the job. Many past failures with such instruments in the boiler house are undoubtedly attributable to the neglect of this latter precaution, and some engineers have made the same mistake with these machines that they made at first with mechanical stokers, and have imagined that as they were automatic in action they did not require skilled attention. The lesson of experience, however, is that automatic apparatus of all kinds demands a well-trained and highly intelligent man to look after it and to keep it in order; and that the most certain way of asking for trouble in the boiler house is to place insufficiently trained men in charge of mechanical stokers and carbon dioxide recording apparatus. When this lesson has been thoroughly learned by chief engineers, the automatic types of CO<sub>2</sub> apparatus will once more come into favor, for with intelligent and skilled attention they can be of the greatest service in maintaining the conditions requisite for high efficiency in the combustion of coal under steam boilers.

## Electric Pig Iron After the War

BY ROBERT TURNBULL\*

AT THE meeting of this society held in Pittsburgh in October of last year I read a short paper on the manufacture of low-phosphorus pig iron from scrap shell turnings in the electric furnace. At the time that paper was read this industry was only in its infancy, the total output in Canada being only about 900 tons per month. Today Canada's output is more than 2500 tons, and by the latter part of November the production will be between 4000 and 4500 tons per month. Furnaces are operating at Orillia, Ont.; St. Catharines, Ont.; Collingwood, Ont.; Belleville, Ont.; Hull, Que., and Shawinigan Falls, Que., the two largest producers being St. Catharines and Orillia, where the output per furnace is about 700 tons per month. Furnaces are building in Lakefield, Ont.; Shawinigan Falls, Que., and Vancouver, B. C., the iron produced in all these furnaces to be used for Canadian consumption with the exception of the production of the Vancouver plant, a portion of which will be exported. Canada at the present time is almost entirely dependent on its

supply of low-phosphorus iron from electric furnaces, its usual supply of blast-furnace iron from the United States being shut off.

A number of improvements have taken place in the manufacture of this iron since I read my former paper. The consumption of electrode has been reduced, some months showing 21 lb. to the gross ton of iron. Kilowatt-hours also have been reduced, the average practice showing slightly more than 500 to the gross ton. Ferro-silicon has been replaced by another product, which reduces the cost and helps the carbon addition. The carbon in the iron is seldom below 3 per cent, and in quite a number of heats 3½ per cent is attained. The cost of producing the iron has gone up, mainly owing to higher labor cost and a general increase on all raw materials, including shell scrap; these items, with the exception of scrap, having increased more than 50 per cent since the Fall of last year.

The following table of 25 consecutive heats shows very clearly the quality of iron being produced today, also the great improvement in the carbon contents:

Heat Number	Silicon <sup>1</sup> , Per Cent	Sulphur, Per Cent	Phosphate, Per Cent	Manganese, Per Cent	Carbon, Per Cent
254	1.02	.....	0.016	.....	3.42
255	1.10	.....	0.019	0.70	.....
256	1.15	0.023	0.017	.....	2.77
257	1.40	.....	0.015	.....	.....
258	1.18	.....	0.019	0.70	3.21
259	1.10	0.020	0.013	.....	.....
260	1.10	0.016	0.021	.....	3.32
261	1.06	.....	0.018	0.70	.....
262	1.00	0.019	0.016	.....	3.17
263	1.07	.....	0.013	0.74	.....
264	1.20	0.012	0.015	.....	3.48
265	1.28	.....	0.017	0.75	.....
266	1.12	0.011	0.021	.....	3.07
267	1.00	.....	0.014	0.74	.....
268	1.02	0.010	0.014	.....	3.09
269	1.02	0.011	0.039	.....	3.18
270	1.28	.....	0.032	0.69	3.36
271	1.07	.....	0.032	.....	3.05
272	1.10	0.009	0.021	.....	3.10
273	1.20	.....	0.030	0.68	2.93
274	1.72	.....	0.022	.....	3.21
275	1.12	0.012	0.028	0.66	3.40
276	1.02	.....	0.027	.....	3.22
277	1.25	0.010	0.013	.....	3.18
278	1.42	.....	0.014	0.66	.....
Aver. analysis,	1.16	0.014	0.020	0.70	3.19

<sup>1</sup>Silicon desired, 1.00 to 1.25 per cent.

Having been asked by the president of this society to give my views on what will be the probable use of furnaces at present engaged in the production of low-phosphorus iron in after the war problems, I will endeavor to do so, although I consider any statements made at present will be in themselves problematic, as they will depend entirely on the state of trade after the war, which at the present time no one can foresee.

### QUALITY NEAR THAT OF BLAST-FURNACE IRON

First of all, the class of iron produced in these furnaces today has not been considered by the consumer to be equal to the grade of iron formerly received from blast furnaces, and, if this is correct, the tendency of the consumer would be to return to blast-furnace iron when he can obtain it. My answer to this is, that the iron produced today in the electric furnace is now so close in quality to blast-furnace iron—it now being possible to attain from 3 per cent to 3½ per cent carbon in this iron—that by the time the consumer will again be able to import iron from the United States he will have become so accustomed to using electric-furnace iron that the deciding factor will be the question of price.

The next question is: Will specifications on steel

\*Paper read at the thirty-fourth general meeting of the American Electrochemical Society in Atlantic City, N. J., Oct. 1, 1918. This paper was read prior to the signing of the armistice. The production figures are, therefore, probably erroneous at this time, but the technique and economics of the process are still pertinent.—EDITOR.



produced after the war, which at the present time allow very high limits for phosphorus and sulphur, be reduced to their former strict limits, which were 0.04 for both phosphorus and sulphur? This issue will have an important bearing on the manufacture of iron in the electric furnace, as should these limits be reduced to their former level, it will be impossible for the steel manufacturer to use the bessemer grade of iron, which he mixes with the low-phosphorus pig, to such an extent as he is doing today, and he will be obliged to use a very much larger quantity of low-phosphorus pig—possibly 100 per cent more. As it is not likely this extra tonnage can be obtained for years to come from the United States, the only source of supply would be the present electric-furnace product. Should, on the contrary, the present high limits be retained the question of price between the two classes of iron would be the determining factor to the consumer, provided the States will be in a position to supply Canada with its requirements in this grade of iron.

#### QUESTION OF SUPPLY CONSIDERED

The next question, and what may be considered the most important one, is: Where will the electric furnaces obtain their supply of low-phosphorus scrap turnings when the present source no longer exists? This brings up another question which will be quite a determining factor in solving the problem, and that is: Will the open hearth continue the use of turnings in the charge, as is being done at present?

I think we are safe in considering that the open hearth will discontinue the use of turnings as soon as it can obtain its supply in heavy melting scrap, as the use of turnings in this furnace involves a greater use of pig iron, and there is a much higher melting loss when turnings are used as compared with heavy melting scrap. This loss is not taken into consideration so much at present, owing to the high prices obtained for the finished product and the impossibility of getting enough heavy melting scrap, but more attention will be paid to this when normal competition again sets in.

Before the war a considerable tonnage of steel turnings was available, and as the production of steel in Canada is now at least 100 per cent more than before the war, we may consider that a very much larger quantity will be produced after the war. Eliminating the open hearth as a consumer, this scrap will become, so to speak, a drug on the market, as it was formerly, and the electric furnace, as a low-phosphorus iron producer, will be the natural customer for this scrap. By paying a small bonus on low-phosphorus turnings, machine shops would no doubt be willing to grade their scrap, as they are doing at present with shell turnings, and this would be a complete answer to our question, provided such conditions could be realized.

We must, however, consider the possibility of an insufficient supply of such turnings and what we would expect to do in such a condition. This would bring us back to the old question of smelting ore in the electric furnace, as this would be the only other source of supply left, if the present furnaces were to be used for the production of low-phosphorus iron. Former experiments have shown that iron ore and steel turnings, mixed in certain proportions, give a production very favorable in proportion to the amount of power

used, and smelting operations are very easy to handle. The furnace which would be used to smelt such a mixture would be of the continuous type, with a load factor approaching 100 per cent, and, as electric steel furnaces have a very low load factor—in some cases not over 50 per cent—the amount of extra power necessary to produce the same quantity of iron from a mixture of ore and steel turnings, as compared with our present type of furnace melting scrap alone, would not be considerable.

About 1400 kw.-hrs. are required to produce one gross ton of iron from a mixture of 50 per cent metallic in turnings and 50 per cent iron ore, so that our present furnaces, which are of 1200 kw. capacity, could produce 20 tons per day of iron, as compared with from 25 to 30 tons using steel turnings alone. I am not prepared to say how the cost of the iron would compare in the case of the mixture as compared with steel turnings alone, but as no ferrosilicon or fluorspar would be required, and the return in metallic contents charged would be 100 per cent as against 90 per cent with turnings alone, besides a great saving in furnace repairs, this would probably more than compensate for the extra power, electrodes and carbon necessary for the reduction of the ore.

A mixture of this kind permits the use of iron-ore concentrates, the charge being kept porous enough, owing to the presence of the turnings, and as these concentrates can be obtained very low in phosphorus, they could be used to advantage in the production of low-phosphorus iron and permit the use of turnings with higher phosphorus contents. As the operation would be conducted in a reducing atmosphere, the resulting carbon in the iron would be perfectly comparable to the blast-furnace product.

Another use to which the present furnaces could be put would be the melting of iron, for foundry purposes. The war having eliminated the exportation of English iron and also iron from the United States, foundries have faced the necessity of confining themselves entirely to Canadian iron, mixed with a very high percentage of scrap cast iron, and, it must be confessed, with good success. As most of the plants which are producing low-phosphorus iron would be suitable for foundry purposes, and as the grade of iron can be controlled very closely and silicon added at little cost, there should be an excellent opening for these furnaces in replacing the cupola for melting purposes, and using nothing but the cheapest cast-iron scrap, including borings, etc., and the metal used direct from furnace to molds, without the use of any pig iron whatever.

#### A New Bronze-Alloy in Norway

A captain in the Norwegian Navy has invented a new bronze-alloy, the so-called M. bronze, which is particularly adapted for bearings, armaments and machinery parts where a comparatively high hardness is required, and for welding and rolling, according to the weekly bulletin of the Canadian Department of Trade and Commerce. In order to satisfy different requirements the bronze is worked out in three qualities, hard, medium hard, and soft. For use where an especially good quality is demanded and for ships' use there can also be produced a finer quality, like mangan bronze.

## Pittsburgh Meeting of the American Ceramic Society

New and Important Data Presented on Graphite, Bonding Clays, Porcelain and Optical Glass—  
Comparative Properties of Foreign and Domestic Graphites—Tests Under Foundry  
Practice—Microscopic Studies of Porcelain—Gases Dissolved in Optical Glass

THE subjects covered by the term "ceramics" seem to include about everything from bricks to bric-à-brac; but the crowd that is back of the subjects is one to be respected. The Pittsburgh meeting of the American Ceramic Society was the twenty-first annual assembly; and President Homer F. Staley in his official address, in opening the program, noted that this meeting was of significance in that it represented the twentieth birthday of the society. He then went on to note some of the past work of the society, as well as some of the desirable policies for the future. Among some of the changes he recommended for consideration:

1. The enlargement of the publication activities of the society, in some increased work of the *Journal* of the American Ceramic Society.
2. The employment of a full-time secretary who should also give his full attention to the editorship of the *Journal* and business management of the society.
3. The selection and establishment of permanent headquarters for the society, in some one of the leading cities of large commercial activity and opportunity in the country.
4. The enlargement of the voting membership of the society, and the possible merging of the "associate" membership with the "active" membership.
5. The consideration of the status of the cement and mortar industries, in closer relations with the work of the society.

The report of the secretary, Professor Charles F. Binns of Alfred University, who is perhaps the dean of American ceramics, showed the satisfactory financial condition of the society, and recommended the appointment of standing committees on the following subjects, which roughly would seem to include the more important branches of ceramics:

1. Glass. 2. Enamel. 3. Pottery and porcelain. 4. Refractories. 5. Brick and tile. 6. Terra cotta and faience. 7. Abrasives.

The formal reading of papers disclosed a large and varied list, some 52 papers being titled for delivery. Most of these were of a high order, both in the selection of topic and in the method of treatment; and it is worthy of note that nearly all of these showed that the contributors were well equipped with the latest theory and technique in their respective lines.

Among some of the more highly emphasized subjects were those of graphite, enamel, optical glass, and porcelain. The subject of graphite occupied most of the program of the first afternoon.

### SYMPOSIUM ON GRAPHITE AND BONDING CLAYS

Mr. M. C. Booze of the U. S. Bureau of Mines at Columbus, Ohio, led in a series of seven papers from that fountain of ceramic activity. Mr. Booze showed

the comparative properties of several bonding clays, in a curve which was made up of the summation and averaging of specific individual properties, such as strength, quenching action, resistance to oxidation, shrinkage, etc. The results are striking, though there seemed to be some doubt as to the reliability of the method of averaging, as compared with desirable practical results, but the paper was only part of the symposium offered by the able set of workers from the Columbus U. S. Bureau of Mines.

Interwoven with this set of papers was one by Professor G. H. Brown (and Mr. E. C. Hill) of Rutgers College, "Properties of Some Bonding Clays and Their Mixtures With Graphite." Professor Brown's paper was quite elaborate, being illustrated with several curves which showed the relations of the plasticity, refractories, vitrification, shrinkage, porosity, etc., at low and higher temperatures of treatment. No attempt will be made to reproduce this very scholarly article, but it may be said that Professor Brown determined the physical properties of a number of typical "bonding clays," for mixing with graphite, when burned under oxidizing and reducing conditions. In addition to typical crucible clays now in use, he also examined a few so-called "low-grade" clays which hitherto have not been regarded as suitable for crucible manufacture. As a result, Professor Brown concluded that the crucible manufacturers have been restricting themselves to an unnecessarily limited field. Some materials which have been hitherto rejected have given surprisingly good service in graphite crucibles of standard size and when used under commercial conditions.

### COMPARATIVE FOUNDRY TESTS ON DOMESTIC AND FOREIGN GRAPHITES

As one paper followed another, most of them on graphite, it became evident that there was a sequence; and this became especially focused in interest in the paper of Dr. Reinhardt Thiessen, on "The Effect of the Shape of Graphite Flakes on the Structure and Durability of Crucibles," and that of Mr. R. T. Stull, on "Tests Under Brass Foundry Practice of Crucibles Containing Ceylon, Canadian and Alabama Graphite." In a word, both of these papers were aimed directly at the main question of comparing American with the best foreign graphite, which has been regarded, till recently, as that from Ceylon.

Dr. Thiessen is an expert with the microscope and the ultra-microscope; and those who had heard some of his earlier papers on related subjects, such as the structure of coal, were prepared to get at something definite, and were not disappointed. Dr. Thiessen showed that the prevailing structure of most American graphites was of rather large and rather rounded grains; and that most of these had such a distinct



lamination that the resulting mixture was sure to be laminated and to show the weakness of laminated cleaving. But the Ceylon graphite was shown to be made up, for the most part, of large and small grains, and with much irregularity of outline, but largely of angular shapes; and the cleavage was not of the always parallel lamination, but of much irregularity in dimension and direction, so that, when mixed in crucibles, the whole would develop a much more coherent mass than was possible with the average American graphite. Moreover, Dr. Thiessen showed that the chemical reaction of most graphites is "acid," which, with the "negative" reaction of most bonding clays, was sure to throw down a precipitate, which would only work disastrously in the desired bonding effect. So he induced "peptization" as a remedy, and with beneficial results; as shown by incidental reference to the ultra-microscopic examination of the well-burnt crucibles.

Mr. Stull's paper, on foundry practice of crucibles with Ceylon and American graphites, followed up this clear impression of some distinct progress in the mastery of the difficulties of finding a substitute for Ceylon graphite. This paper was all the more gratifying because it threw much light on the recent newspaper reports that the American manufacturer had been able to substitute for a considerable amount of Ceylon graphite the home product in the making of crucibles.

These tests were so conducted that they would well simulate the conditions of actual practice. The number of heats was noted, and this runs from ten to thirty or thirty-four, depending on the composition of the crucible, the conditions of manufacture and the kind of use the crucible might receive at the hands of the workman in the factory. Moreover, the crucibles were subjected to the action of two kinds of brass, one which melted easily and had a "mild" action on the crucible, and another that exerted a rough and heroic action on the crucible, both in the manner of melt and in the temperature of melt. Mr. Stull's paper was accompanied by several remarkable groups of curves, which showed many of the conditions of composition and treatment, running all the way from 100 per cent Ceylon and no American to no Ceylon and 100 per cent American graphite.

The best type of American graphite was found in the Alabama variety, but this Alabama graphite is mainly of a "flaky" texture and so, to change the flakes to grains, recourse was had to coking it in briquets, compressed under high pressure with tar as a binder. The anticipation was that the grains thus produced would act better than the original flakes of this Alabama graphite, but just the contrary was found to be the case. Incidentally, one of the seven papers from the Columbus workers was devoted to the effects of this variable pressure and tar content in briquetting the Alabama graphite.

#### GOOD RESULTS FROM ALABAMA GRAPHITE

In the main paper, by Mr. Stull, it was shown that, while some of the lowest and some of the highest number of heats possible for the crucibles were found for the straight Ceylon graphite, yet the careful tracing out of the curves of the mixtures of the Ceylon with the Alabama flake and the Alabama grain (coked) and with the "mild" and with the "hard" brass showed

that some of the best maxima of possible heats were obtained with mixtures of the Alabama flake, and with increasing proportions of the latter. To be sure, these results are only tentative, and were advanced as showing the possibilities, but as such they are distinctly encouraging.

It must also be said that the conditions of working were arduous and exacting in the extreme. It takes nearly a month's waiting to manufacture a graphite crucible of the size used—about No. 60—and after that, when the crucible gets to the foundry, it ought to have three or four weeks more to dry out thoroughly; and doubtless many of the crucibles tested were not sufficiently aged and dried out to rightly undergo the best strains of practical efficiency. There were also many incidental points of interest; as the correspondence between wholly different curves, as the rising and falling at the percentage composition points of about 23 per cent, about 45 per cent and about 68 per cent of American (Alabama) flake—rising at 100 per cent in one case to over 28 heats per crucible. Moreover, the tests were conducted in sets of ten crucibles, and the correspondence of heats endured in the same set was very good.

Following the group of papers on graphite, there were the distinct sets of papers on enamels, on porcelain and on glass and optical glass.

#### SIMPLE CHEMICAL TESTS FOR ENAMELS

In the enamel group should be noted the very practical paper by Mr. E. P. Poste of Elyria, Ohio, who described his search for some cheap, readily available and fairly constant acid which might be used by the large group of manufacturers who would not stop to employ expensive chemical tests but who needed some standard for the solvent effect of common solutions on enamel in its common uses. After a careful comparison of such acids as acetic, hydrochloric, nitric and sulphuric, he found in citric and tartaric acids almost the desirable objects of his quest. These acids are solid substances, they can be bought at every drug store, and they are fairly stable and permanent in storage. Thus it is perhaps possible to recommend a simple formula for the use of those interested, by means of which the solvent action of culinary solutions on enameled ware can be easily studied on a common standard. Moreover, citric and tartaric acids represent the common fruit solutions of domestic use to which enameled ware is commonly subjected. The tests were not quite complete with the paper, but the indications are that tartaric acid is perhaps the more desirable, as it can be easily obtained, and a standard solution can be made up, by weight, and with the simple addition of water.

Mr. Poste also described a search for clays by which to control the fusion temperature of enamel, illustrated by a curve of relative differences of increased temperatures of fusion.

Mr. P. D. Landrum of Cleveland described an attempt to make an enamel, using the clouding effects of titanium oxide (rutile) instead of the well-known tin-white substance. He found the presence of iron, which, strange to say, did not seem to control the color, though it may have interfered with it. But while he obtained the opaque effect, he invariably obtained also a yellow-

ish tint, which is not considered desirable in the trade. He noted the inference that the titanium, or some titanium compound, is precipitated in part in the enamel as "invisible" microscopic crystals.

#### BLISTERING OF ENAMELED STEEL CAUSED BY ENTRAINED GASES

One of the most interesting papers in the enamel field was by Mr. Chester Treischel and Mr. L. E. Barringer, of the General Electric Co. at Schenectady, on "The Cause and Control of Blistering in Sheet Steel Enameling." This paper was prefaced by the exhibition of some remarkable samples of "blistering," some of the specimens showing blisters of several inches in diameter. These were not between the enamel and the steel sheet, but were clearly in the steel body itself, causing the steel to split or laminate itself into still thinner layers. Mr. Treischel noted that metals are known to absorb and to transmit gases with great readiness, and the metals do not give off all of the absorbed gas on simple heating. Moreover, in the process of rolling thin sheet steel, it is a common matter for small bubbles of air to become entrained between the sheets, and these bubbles of air are often rolled out between the sheets, with the metal, attaining to a considerable area. These entrained gases, as hydrogen, or some of the entrained air, may cause serious difficulty. Tests were made to find the conditions of avoiding the absorption of hydrogen in "pickling," and it was found that by the use of a 3 per cent solution of acid the time was not seriously increased, and with careful rubbing off of the scale, before washing, better results were obtained.

Of course, many of the subjects must of necessity overlap; and this was well illustrated by papers on "The Manufacture of Glass Pots" and "The Casting of Porcelain Pots," which naturally were grouped together. As the program approached the manufacture of optical glass, interest was quickened by papers that brought out the nature of the elaborate and refined methods used.

Mr. W. S. Williams and Mr. C. C. Rand gave a paper in which this careful, methodical system was magnificently shown. The successive operations of drying the pots, burning the pots, melting the charges, stirring the melt, cooling the melt, and annealing the melt—each and all of these were shown to be carried on with the most refined control both of temperature and time; so that at any stage of the process the treatment of the pot or of its contents was guarded and foreordained with the utmost nicety and exactness, both in temperature and in time allowed. One interesting detail was a curve of the "stirring circles" followed. Another nice contrivance was the diagram of a "stirring-rod thimble," the use of which was obvious but which shows the nice attention given to the avoiding of contamination in the stirring of optical glass which seems to be an indispensable part of the process to secure uniformity of mixture and the removal of bubbles.

#### GASES DISSOLVED IN OPTICAL GLASS

But perhaps the most startling and suggestive paper on optical glass was one by Professor E. W. Washburn of Urbana, Ill., entitled "Gases Dissolved in Optical

Glass." He illustrated the subject by referring to the escape of carbonic acid from common "soda water." With this test as a cue, he described the attack on optical glass. The fundamental experiment was one in which a sample of good glass was melted in an inclosed steel box; then the interior of the box was connected with a vacuum, on which the whole pot of melted glass, finding escape for its contained gas possible from the reduced pressure, foamed up over the top of the pot, and this foamy glass when cooled resembled a light, spongy mass, as one can imagine who did not see the sample passed around. Professor Washburn then described in detail how he followed up the isolation of such occluded gases, and the analysis thereof, certainly determining eight-hundredths of one per cent of oxygen, by weight, and three-hundredths of one per cent of carbonic acid, a total of eleven-hundredths of one per cent by weight of dissolved gases. The mere momentary inspection of Professor Washburn's samples is enough to suggest the nature and complexity of the new problems involved in the production of perfect optical glass.

This was followed by a paper on "The Defects and the Testing of Optical Glass," by Mr. A. R. Payne of the U. S. Bureau of Standards at Pittsburgh. This remarkable paper, which without the accompanying slides is only "Hamlet" with Hamlet left out, gave a clear catalog of the "seeds, striæ, stones and strains" found in optical glass and which must be avoided. In detail, it may be noted that Mr. Payne noted the "sheet," the "band," the "comet," the "hair" and the "surface" striæ, with some directions as to their causes. It is to be hoped that most of these illustrations may be preserved and published.

#### PRACTICAL MANUFACTURE OF OPTICAL GLASS

Of course, much of the program was characterized by refined theory and practice, but the charge of undue theoretical treatment of subject was well offset by such a paper in the optical glass list as that by Mr. George W. Morey of the Spencer Lens Co. of Buffalo, who gave the society a most admirable digest of his own actual and practical experience in making optical glass for the U. S. Government. He described in detail, briefly and to the point each of the stages of his method and treatment. One of the charms of this paper was the original and commonsense way in which Mr. Morey analyzed the conditions of initial and partial melting of the charge, with the inevitable results that those conditions must have on the rest of the charge and on the subsequent treatment. Thus, if the charge melts first at the top, then the part melted first flows down through the rest of the unmelted charge, leaving the top of the charge deficient in fluxing power. Moreover, this top part of the charge is the part through which the later escape of the gases given off must take place. Follow up this simple mental picture, and Mr. Morey's method of cutting out the hand stirring and introducing the mechanical stirring at each of the introductions of the parts of the full charge, and it is easy to see why he attained a complete cycle of treatment in a regular run of two days, and with most excellent results.

The subject of porcelain received much attention in quite a number of interesting papers, both from the theoretical and the practical standpoint.



It seems to be the gradually growing consensus among the experts who have given the matter careful consideration that the body of well-baked porcelain, and that having the most perfection of strength, translucency and resistance to solvent chemicals, is characterized by the generous production of a mat of interwoven crystals of sillimanite. Now, sillimanite is a well-known mineral, which occurs in certain gneisses, granites and similar rocks; the chemical composition of sillimanite is given as  $\text{Al}_2\text{SiO}_5$ ; and the mineral is connected with its petrographic brethren, andalusite and kyanite, in that they all have the same empirical composition. The study of thin sections of porcelain mixtures shows that sillimanite is gradually produced as the quartz is absorbed by the matrix of the melt, and the approximation to the perfect porcelain composition and texture is paralleled by the attendant growth of the needles of sillimanite. All this was repeatedly shown by such good papers as that by Mr. A. B. Peck of the U. S. Bureau of Standards at Pittsburgh and of Mr. A. S. Watts of Columbus, Ohio; and some of the same methods of examination were employed by Messrs. J. W. Wright and S. I. Sewell of the U. S. Bureau of Standards at Pittsburgh, in their paper on "Some Physical Properties of Commercial Porcelain Bodies."

A typical mixture for making porcelain may be taken as 15 to 20 per cent of quartz, 30 per cent of feldspar, and the balance of ball clay and china clay in about equal proportions, say 25 per cent of each. Now, Mr. F. H. Riddle, in his paper, "Further Studies in Porcelain," showed that the development of the desirable structure and properties of good porcelain seemed to be largely dependent on the length of time used in grinding, not half an hour to an hour, as is the usual custom in commercial practice, but two or three hours. Further, Mr. Riddle showed that this extra grinding seemed to produce better results than quenching, and the extra time given to grinding seemed to be more important than the percentage of feldspar added to the original mixture. He also noted the remarkable influence of small quantities of oxides of calcium and magnesium in shortening the time of "maturing" the melt, and at a somewhat lower temperature.

The special question of casting pots for melting porcelain mixtures was considered in a well-illustrated paper by Messrs. J. W. Wright and D. H. Fuller of the U. S. Bureau of Standards at Pittsburgh.

The incidental use of the holder or jar for ball-mills was considered by Mr. C. W. Parmelee of Urbana, Ill., in a most interesting paper on "Porcelain Bodies for Ball-Mills," in which he examined in detail the various mills and machines for getting at the main idea of what is done and what is meant by the work and effect of "impact" and "rattler" in the tests. Comparative results were given for the action on quartz, clay and feldspar and the subject will be pushed to ascertain the best material for the ball-mill container.

#### DEFECTS IN PYROMETER PROTECTION TUBES

One interesting phase of the actual necessities of present practice and of not finding material that ought to be at hand, but is not, was brought out in the paper by Mr. F. A. Harvey, of the Semet-Solvay Co. at

Syracuse, N. Y., on "Porcelain Pyrometer Protection Tubes." This paper disclosed a most distressing state of things. Mr. Harvey is manager of a practical commercial laboratory, and while there are optical pyrometers that can give the thermal conditions for almost any temperature, yet it is indispensable for his work that he should have a graphic record to trace the stages of work. He had a pyrometer protection tube of some unknown make of fireclay that worked beautifully, but on its accidental breaking from the carelessness of a workman, he was unable to find a satisfactory substitute. Among all the attempts he made he found nothing completely satisfactory for the high temperatures involved—some 1450 to 1500 deg. C.—but the most approximate material was found in a "S. C. P." tube from Japan. The suggestion was made in the discussion that there are or ought to be registering optical pyrometers that would serve the purpose; but that does not seem to be quite worked out for the conditions required in Mr. Harvey's work. The paper is only another evidence of the quick response of American technique to the live needs of the times.

#### CAUSE OF DIELECTRIC FAILURE OF PORCELAINS

Probably one of the most dramatic features of the porcelain papers was brought out in those bearing on the existence of quartz in porcelain, and its undesirability. This question was brought out, without evasion or camouflage, by Mr. A. S. Watts of Columbus, Ohio, in his paper, "An American Porcelain Containing No Free Quartz," and further sharpened by the "Suggested Discussion" on "A Possible Cause for the Dielectric Failure of Porcelains Which Are Apparently Free From Mechanical Defects," by Mr. Chester Treischel of the General Electric Co., supported by Mr. L. E. Barringer of the same company. In a word, the theory was put forward by Mr. Treischel that quartz is affected by the high potential strains of the alternating current. It is well known that when quartz crystals are subjected to high potential charges, at opposite axial points, they also become subject to distortion in dimensions and figure, and these may result in strain and fracture. This is the well-known "piezo-electric" phenomenon (pressure, electric strain). This may explain the failure of porcelains otherwise well fitted to endure the high potentials of insulators. Mr. Treischel, with most naive witticism, frankly confessed the danger of speculation, as he enumerated the three uses of a theory:

1. To explain facts as they are.
2. To develop further facts.
3. To give intellectual satisfaction.

Mr. Barringer read several letters from various noted specialists, giving more or less admission to the new theory, but he was frankly looking for light; and when such men, from such companies, frankly avow their sense of need for further light, it betokens some possibility of unlooked-for progress. Mr. Barringer noted that there are a dozen oxides that might be used as substitutes for quartz in porcelain, but this may be regarded as only the beginning of a new and marvelous chapter on the composition and manufacture of high-grade insulating porcelain.

In addition to the formal program, there was the usual banquet, presided over by Professor C. F. Binur.



ANNUAL BANQUET AT ASTOR, FEB. 4, 1919

Seated at the speakers' table are (from right to left): E. R. Behrend, J. Newell Stephenson, Dr. Charles P. Steinmetz, Thomas J. Keenan, Secretary T. A. P. P. I.; George W. Sisson, President A. P. P. A.; Justus A. B. Cowles, G. H. Mead, H. P. Carruth, President T. A. P. P. I.; Judge Charles F. Moore, Toastmaster; Robert W. Wolf, Henry E. Fletcher, Stuart D. Lansing, Dr. H. P. Baker, W. F. Robertson, Raymond S. Hatch.

## Paper Associations Hold Joint Convention

Annual Meeting of the American Paper and Pulp Association and the Technical Association of the Pulp and Paper Industry—Economic and Technical Questions Discussed—Vocational Education Campaign in the Pulp and Paper Industry to Be Prosecuted

THE Technical Association of the Pulp and Paper Industry held its fourth annual convention in New York Feb. 3 to 6, conjointly with that of the American Paper and Pulp Association, in which body it was elected an organization member. It was decided that the scope of the A. P. P. A. should be extended to include the paper product manufacturers such as fine stationery, writing tablets, fiber containers, envelopes, merchandise bags, wall paper, etc., in addition to the present member organizations, who are strictly engaged in the manufacture of primary products such as binder board, cardboard, cover paper, glazed and fancy paper, gummed paper, tissue paper, vegetable parchment, waxed paper, wrapping paper and pulp.

The TAPPI program of forty addresses and committee reports was very inviting and brought forth about two hundred members from all parts of the lands of the eagle and maple leaf. Dr. C. P. Steinmetz of the General Electric Co. was the guest of distinction and proved his versatility by delivering an address on "The Principles of Waste and By-products." The keynote of his address was that chemistry is the greatest of the sciences, that the coal-tar industry is an example of man learning to control and utilize all the products given to him by nature and that the pulp and paper industry should make every endeavor to find uses for its marvelous wastes and turn them into by-products.

As the addresses, discussions and reports will be printed in full in the current issue of *Paper*, no attempt will be made to review the meeting in sequence but brief notes will be made to witness that the paper industry gave evidence of broad industrial scientific activity. In connection with Chairman Martin L. Griffin's

report on the black ash furnace alkali stack losses, the Cottrell electric precipitation process was thoroughly discussed. The Brown Company has taken the initiative and installed the process in its Canadian sulphate plant, where it will receive capable development and perhaps lead to broad application in the alkali pulp industry. Mr. J. A. DeCew described his flotation process as entirely successful in recovering the pulp and china clay from the waste liquor from the Fourdrinier screens by simple air foaming and floating off the concentrated solids with a yield as high as 80 per cent. Not much good news was forthcoming about sulphite liquor, a small amount of highly refined concentrate being reported as in use as leather filler, and the raw concentrate as core compound and road binder, but the exhaust lines to the river still are carrying their polluting charge in undiminished volume.

### THE MORTERUD PROCESS

The Morterud forced circulation external heater process of cooking pulp was described by O. L. Berger. The advantages to be gained by the successful operation of this process are revolutionary, but it is found that in American installation to date troubles have been experienced in getting tubes for the heater that will stand up against the corrosion of the circulating liquor. The process is reported by Mr. Berger to be working very successfully in Norway and full knowledge of the materials of construction used there are expected to make equally successful operation possible here. As the war has made it difficult to set stringent specifications and get delivery, it is hoped that the enterprising manufacturers who have taken chances and invested in this



new type of equipment will be able to obtain satisfactory tubes. If the Morterud process proves to be materially practical, much less digester liquor will have to be used and real progress will be made in reducing the volume of this waste to economical concentration.

"Common Sources of Error in Sulphite Liquor Testing," by W. E. Byron Baker, was a thorough discussion of analytical work, but would have served to better purpose if printed copies had previously been sent to the mill chemists so that time for real consideration of the author's new method could have been available and discussion held at the meeting. Great interest was not excited, as all but a few members adjourned to the halls.

#### SELECTING SUITABLE EMPLOYEES

The popular talk on vocational analysis for selecting suitable employees, by Dr. Katharine M. H. Blackford, was keenly listened to and made so favorable an impression that the time was extended another hour to allow the little wizardess to tell all about the vocations that the outer appearances of Messrs. Wolf and Fletcher indicated, and true to her reputation as an employment manager, she filled them out a card for the very jobs at which they are recognized by all the members of the association as eminently successful.

Dr. T. Poole Maynard spoke concerning the American clays and requested that the paper manufacturers co-operate with the kaolin producers in adapting our great domestic resources to this field. Dr. Maynard believes that some of the infinite variety of the American china clays are suitable and that the greater the co-operation the sooner will the problem be solved. Points brought up were that the pulverized and air floated clay contained much abrasive grit which cut the wire cloths seriously. Alkaline earths were also mentioned as undesirables, forming mineral soaps with the resins and perhaps giving rise to the so-called "tiny sheet." As most secondary clays were deposited in the presence of marine life, small amounts of lime are usually present, even when the reef formations are not found in immediate connection. No doubt the ground water of the entire territory below the crystalline line contains lime salts. However, there are some primary clays in Northern Georgia and Alabama which have been passed up by the investigators that are free from even traces of alkaline earth bases and with proper aging and preparation will resemble the imported material more closely.

Several of the groundwood mills are reported as having trouble with rusting pulp. One plant recently burned five hundred tons for fuel. When the rusts are examined under the microscope, a small black worm is found. Mr. John Stadler reported that his plant had had a touch of it several years ago and that it had been found that if the pulp was sterilized with chlorine, no rust worms would develop during storage.

#### VOCATIONAL EDUCATION FOSTERED

The greatest activity of the association is probably its endeavor to foster vocational education in the pulp and paper industry. It is now about to get a treatise out by contributions of a large staff of specialists on the following: Wood preparation, sawing into blocks, conveyors, piling, measuring, barking, drum and knife barkers, hand cleaning, splitting, chipping, screening,

rechipping, drying, conveying to drip bins, hazards, mechanical pulp, kinds of woods, conveying blocks, types of grinders, Hall process, operation of grinders, dilution of pulp, losses, power, hazards; treatment of pulp, sulphite pulp, soda pulp, sulphate pulp, bleaching pulp, analysis and testing of pulp and raw materials, analysis of allied paper materials, preparation of rag and other fibers, esparto, waste papers, beating and mixing, loading, sizing, coloring, paper making, the paper machine, tub sized papers, finishing operations, special Fourdrinier machines, cylinder machine, special papers and boards, paper testing, trade customs, general mill equipment, laboratory equipment, glossary of terms. The association expects to spend \$30,000 in preparing the manuscript, which will be turned over to a publishing concern for printing. This is the first time any large industry has followed such a program and no doubt the benefits to be derived will be as great as anticipated. Several other branches of industry will do well to follow this excellent example.

#### New Work in Wood Chemicals

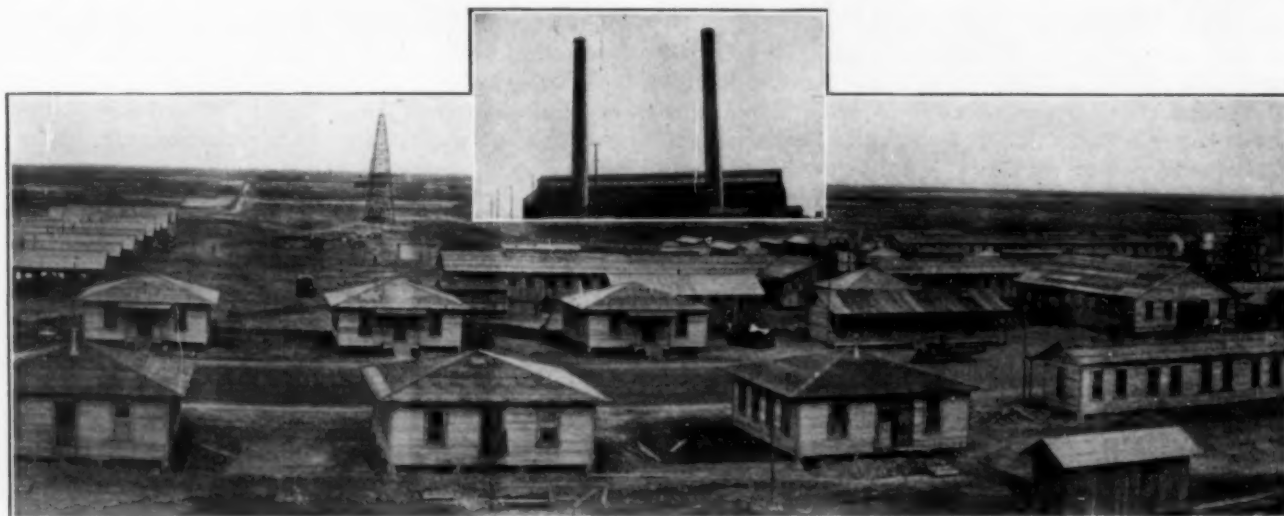
Researches by the chemists of the Forest Products Laboratory at Madison, Wisconsin, upon the production of ethyl or grain alcohol from wood waste which before the war made possible a materially increased output were continued as a means of conserving foodstuffs and of relieving tonnage for overseas transport. Similar researches to produce the same product from waste sulphite liquor in pulp making have shown and demonstrated commercially that the yield of ethyl alcohol from this source can be increased more than 50 per cent.

Field studies were made and aid was given during the war to several large hardwood distillation plants upon the matter of temperature control as a means of increasing output. By use of proper method the increased output amounts to 3 gal. of 82 per cent spirit per cord and the acetate of lime product was increased as much as 5 lb. per cord of wood distilled. In addition to this, large quantities of fuel were conserved, due to the more efficient temperature regulations. This work supplemented much more extensive efforts conducted before the war.

Extensive researches were carried out upon the preparation of acetic acid by the fusion of sawdust with sodium hydroxide. It was shown that 15 to 20 per cent of the dry weight of the wood can thus be converted into acetic acid. This work is at present awaiting commercial or large-scale application.

#### Novel Use for Carbon Dioxide

Carbon dioxide has been successfully used in Australia for exterminating the weevil which has been destroying stored wheat in vast quantities. The infected wheat is stored in air tight stackhouses into which carbon dioxide is pumped until the live weevils are destroyed. The eggs and grubs which remain are killed by heating the wheat in special machines to 140 deg. F. for three minutes. It is claimed that the character of the wheat is unaffected and that there is no tendency for weevils to develop again unless exposed to a fresh source of infection.



## American Sulphur Industry Expanding

**Brief Account of the Sulphur-Bearing Saline Domes of the Gulf Coast—Operations at Matagorda, Enormous Boiler Equipment, Water Superheaters and Pumps—Fuel Cost of Primary Importance Because of Low Heating Efficiency**

**D**UE to the patents granted to the late Herman Frasch during the period from 1891 to 1903, the sulphur industry has grown up in the United States under a patent monopoly. The development of the Louisiana deposit has long been recognized as a noted achievement, though it was as recently as 1912, when the Perkin Medal was awarded to Mr. Frasch, that scientific literature began to bear any appreciable American sulphur content. How extensive the formations and what the origin of these great subterranean masses of sulphur were has never ceased to excite the keenest attention. Those who have studied the formations of the southern sections of the Gulf States, Georgia and all of Florida do not require elaborate geological theory to understand that this area is entirely of sedimentary origin, with the northern outcrops of the inclined strata indicating a thickness at the present coast of about 12,000 ft. This two-mile depth of fill may be said to consist entirely of the decomposition products of the original continental rock formation interspersed with marine animal remains. During the varying life and climatic periods, many individual strata were formed. It is of interest to note that great dislocations have taken place in these strata, especially near the present coast line, with resulting vertical seams offering free channels for the upward and downward passage of ground water. Whether the tidal forces due to the shifting waters of the Gulf or strains set up by temperature changes, etc., brought about these faults is open to conjecture. That similar eruptions are taking place in this locality during the present period is evidenced by such catastrophes as the Galveston tidal wave in 1900. The gulf being shallow, major subterranean eruptions in its floor are followed by high seas.

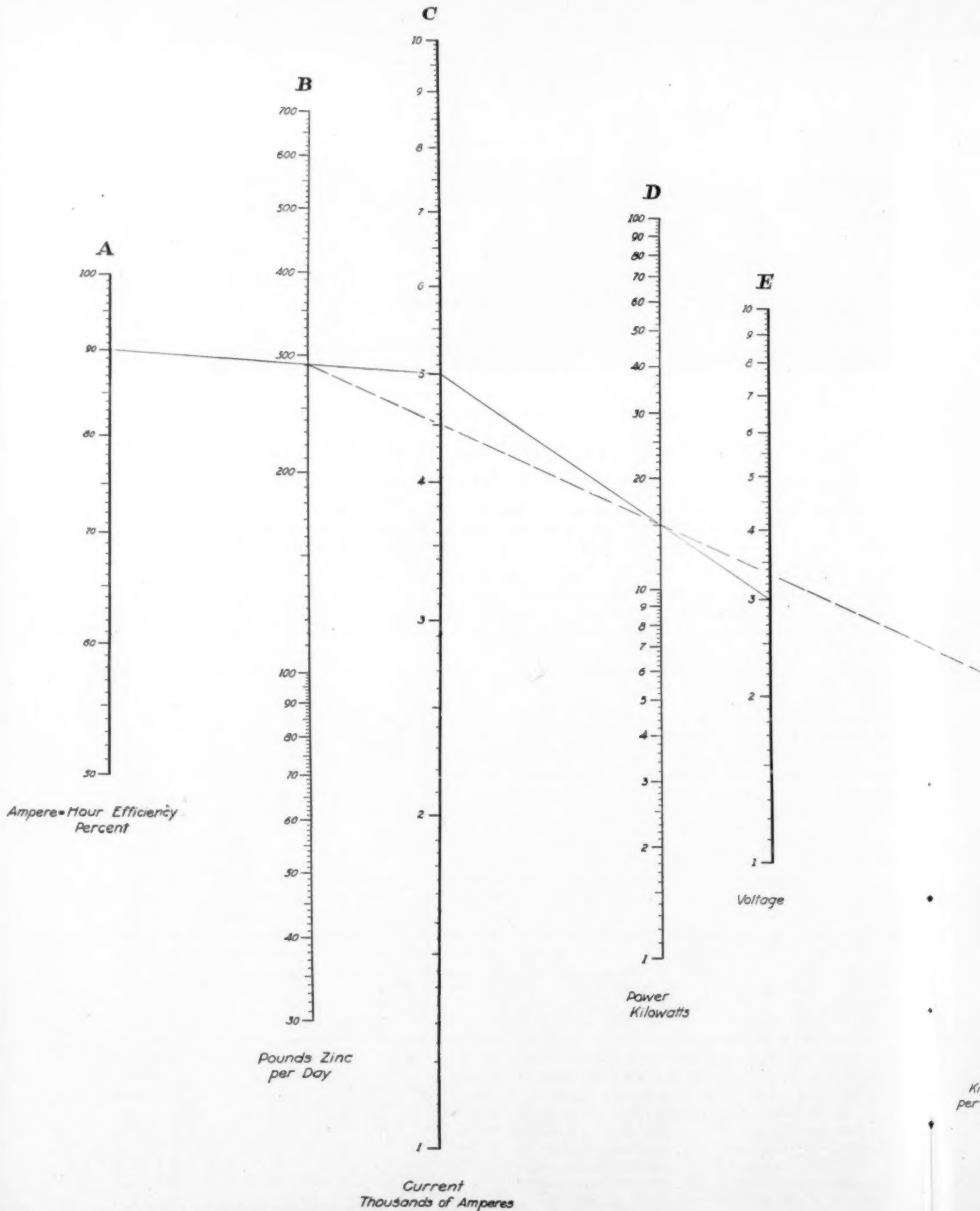
At certain points along these faults the so-called dome phenomena take place. As is well known, rock salt and large bodies of either petroleum or sulphur occur in them, the origin of which may be due to the brine being concentrated to saturation in the hot zone at the base of the fault, the destructive distillation of the marine fossils and the reduction of the sulphates by the hydrocarbon in some instances with the ultimate result that great quantities of sulphur are produced and the available petroleum consumed. There are many of these sulphur deposits in the Gulf Coast region, but commercial mines are at present confined to three localities only. The Union and Freeport Company properties have been long in operation, while the third, located near the mouth of the Colorado River at Matagorda, Texas, is now 90 per cent equipped for operation and will be known as the Texas Gulf Sulphur Co.

The surface indications of the domes are low mounds rising a few feet only above the flat alluvial plain which constitutes the Gulf Coast section. In the case of the Matagorda dome, the elevation above the plain is only some 15 feet with a diameter of approximately 3500 feet. The elevation is so slight that it cannot be distinguished in a photograph, the steepest grade being under 2 per cent. On the surface, the dome consists of alluvial material with no rock outcrop of any kind. Wells were originally located on these domes because of their elevation and small liability to be flooded during storms.

After the discovery of oil at Spindle Top near Beaumont, Texas, many domes were explored for oil, among others that at Matagorda. The mound produced some oil, but the total output was small and it was soon abandoned as an oil field. In the course of drilling for oil, sulphur was identified in the cuttings from several wells. At the time, however, little importance was attached to









# Power Data for Electrolytic Zinc

By G. H. CLEVINGER AND F. S. MULOCK

THE accompanying straight line diagram shows graphically the relationships between the principal electrical data involved in the production of electrolytic zinc. It will be noted that each vertical line is subdivided into a logarithmic scale. The position and scale of the heavy lines A, C, E and IJ are first arbitrarily laid off.

The position and scale of line B, which represents the product of A, C and a constant, is then determined from the arbitrary scales on lines A and C. As line A represents ampere-hour efficiency and line C current in amperes, their product, when multiplied by time and the electro-chemical equivalent of zinc, will give the weight of zinc deposited for that time. Here the constant used was such that the scale of line B represents pounds of zinc per 24-hour day.

Similarly, the product of line C, representing current in amperes, and line E, representing voltage, is given on line D, which represents power in kilowatts.

Line D, representing kilowatts, multiplied by 24, gives kilowatt-hours per day. This product divided by line B, representing pounds of zinc per day, gives kilowatt-hours per pound of zinc, which is represented by scale F on line FG.

Using the theoretical decomposition voltage of the electrolyte and the electro-chemical equivalent of zinc, it is possible to determine the theoretical kilowatt-hours required per pound of zinc. This value divided by the actual number of kilowatt-hours per pound of zinc (as found on scale F) gives the power efficiency. Scale G gives the power efficiency for a zinc sulphate electrolyte.

Line IJ gives the cost of power both in cents per kilowatt-hour and in dollars per kilowatt-year. From scale J of line IJ and scale F of line FG is determined the line H, which represents the cost of power in cents per pound of zinc.

The following problem will illustrate the use of the diagram:

Given: 1. Current, 5000 amperes. 2. Ampere-hour efficiency, 90 per cent. 3. Voltage, 3 volts.  
4. Cost of power, \$20 per kilowatt-year.  
To find: 1. Pounds of zinc deposited per day. 2. Power in kilowatts. 3. Kilowatt-hours per pound of zinc. 4. Cost of power in cents per pound. 5. Power efficiency.

1. Place a straight edge on 90 of the A scale and 5000 of the C scale. Read pounds of zinc per day (291) at point where straight edge intersects the B scale.

2. Set at 5000 on scale C, and 3 on E, and read power (15 kw.) on D.

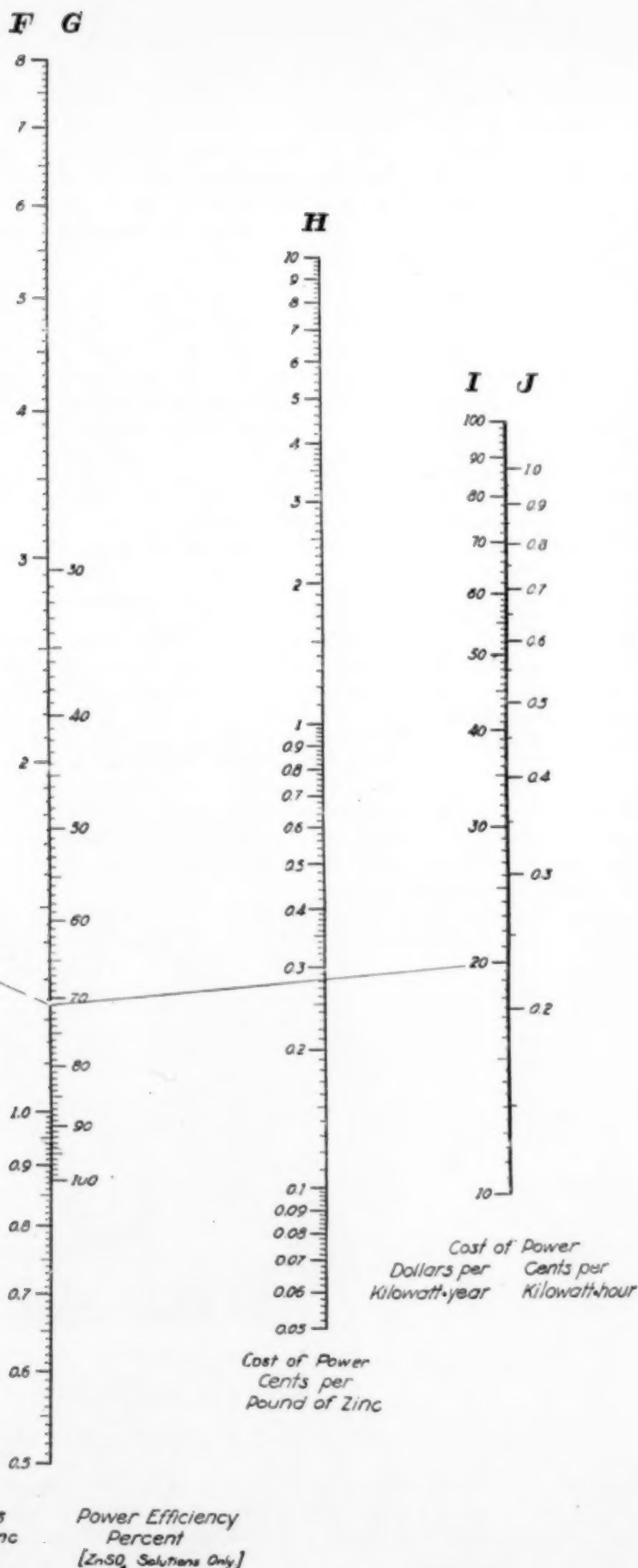
3. Set at points determined in 1 and 2, i.e., 291 on scale B and 15 on scale D; read kw.-hr. per lb. of zinc (1.24) on scale F.

4. Set at 1.24 on scale F and 20 on scale I, and read the cost of power per pound of zinc (0.283 cents).

5. With the same setting as in 3, if the electrolyte is zinc sulphate, read the power efficiency (71 per cent) on scale G. (This scale cannot be used for electrolytes other than zinc sulphate.)

Note: The voltage to be used on scale E is the voltage per cell. When cells are connected in series, divide the total voltage by the number of cells. The output of each cell may be ascertained by using the average current per cell on scale C. The total output of the plant may then be found by multiplying this result by the number of cells in use.

Similar straight line diagrams can be prepared showing the relationship between the electrical data involved in the electro-deposition of the other metals.



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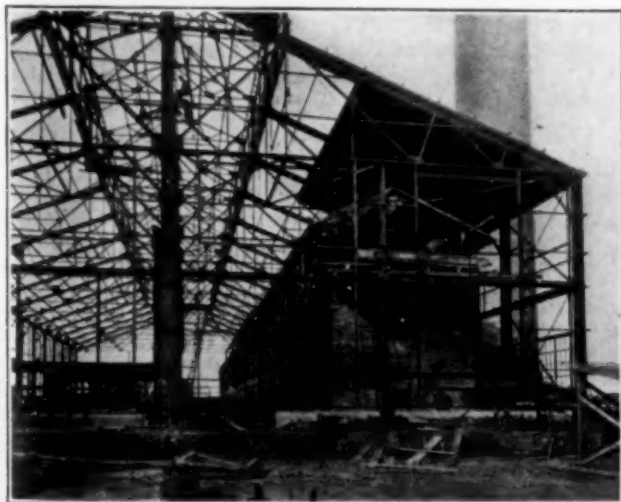


the presence of sulphur. At a later date, the existence of important quantities of sulphur was proved, but the dome was not thoroughly explored until the Texas Gulf Sulphur Co. started drilling in the summer of 1917. Extensive drilling has confirmed the early records, and the deposit ranks today as one of the largest and most accessible sulphur reserves in the world.

The company was disposed to postpone the erection of a boiler plant until the end of the war, but the increasing demands of the Government for sulphuric acid and the possibility of a shortage of sulphur-bearing materials made it advisable to begin construction immediately. With the encouragement and priority grants of the Government, the company has erected during the war a modern boiler plant with all accessories and equipment needed for economical operation. The company will probably start production within sixty days at a rate of not less than 1000 tons daily. The reserves of high-grade ore, stated to contain at least several million tons of sulphur, are adequate for many years' production.

#### MATAGORDA DOME

The conditions found by drilling show a very flat-topped (practically horizontal) salt dome occurring at a depth of about 1000 ft. below the surface. The salt has not been drilled through, but is presumed to be of great thickness. Overlying this conformably is a stratum of salt and gypsum, while above this is the sulphur. The strata containing the sulphur show alternating layers of calcite and some gypsum. The sulphur horizon has been stated to be in the form of a half-dome, so that while the strata of gypsum and calcite are continuous,



BOILERS, PUMPS, ETC., USED IN HEATING ABOUT FOUR MILLION GALLONS OF WATER TO 325 DEG. F. WITH WHICH THE SULPHUR IS MELTED

a portion of these strata on one side of the dome contain little or no sulphur.

Above the sulphur horizon is a series of sediments consisting mainly of gumbo, shales (with shell), clays and sands. Embedded in the unconsolidated sediments are masses of limestone.

On the sides of the dome, where the dip is steep, drilling shows that the unconsolidated sediments extend to much greater depth, the underlying rock strata not having been reached. There is, then, not a

mere flexing of the strata, but a distinct rupture involving immense forces over a comparatively small area. Subsequent erosion of the surface has left only small mounds to indicate the great displacement under the surface. In the nature of the case no correlation of upper strata is possible between various drill holes, nor is the sulphur horizon overlaid by the same formation in all cases. In general, of course, the limestone beds are found to be thicker and more numerous as greater depth is attained. In the case of Matagorda it might be more correct to refer to the dome as a plug practically flat on top with nearly vertical sides.

The manner of occurrence of sulphur in the mounds of the coastal plain region makes prospecting hazardous and expensive. There is no surface evidence except that furnished by the topography, and many of the mounds have been proved to be barren of both oil and sulphur. The physical character of the sulphur horizon has an important bearing upon the success with which the superheated water process may be applied. The formation must be sufficiently open to permit the hot water to circulate rapidly. Its depth and the overlying strata must be such that hydraulic and steam pressures can be maintained. The formation should be free from large subterranean water channels or passages through which the hot water might escape without obtaining sufficient contact with the sulphur. It is stated that the Matagorda deposit fulfills all these conditions to a desirable degree.

#### MAIN FEATURES TO BE CONSIDERED

From a practical standpoint, the main features to be considered in sulphur operations are transportation, fuel and water. As the product mined is cheap, it is apparent that a low transportation cost to the main sources of consumption is required to maintain economical prices. The Matagorda deposit is located on the Santa Fe Railway and being only two miles from Matagorda Bay and seventy-five miles from Galveston, will enjoy cheap ocean freights to the Atlantic seaboard as well as to foreign markets.

Fuel oil is obtainable at low cost either from the Texas oil fields or from Mexico in tank steamers. The company will require a minimum of 2000 barrels of oil daily.

The fuel efficiency of the process adopted in mining the sulphur is very low, generally under 3 per cent, comparing the heat units in the fuel with the heat necessary to melt the sulphur. A great deal depends on underground conditions. In some cases, large water courses are present which dissipate the hot water and reduce the efficiency. None of these openings have been found at Matagorda, however, so a high heat efficiency is expected. The main cost of producing sulphur is in the enormous fuel consumption, and the commercial success of the Frasch process was due to the low cost of fuel oil. It is estimated that from three and one-half to four and one-half million gallons of fresh water will be required daily, and in order to obtain this large supply shallow wells have been sunk and arrangements completed to utilize Colorado River water.

The pumping station occupies a space about 280 ft. long by 100 ft. wide. The equipment consists of fourteen 702-hp. Stirling boilers, oil fired, equipped with soot blowers and designed for 200-lb. steam pressure;

two 500-kw. General Electric steam turbo-generators, non-condensing, 2300 volt, 60 cycle, 3-phase; four Laidlaw steam-driven air compressors, each with displacement capacity of 475 cu.ft. per minute at 500 lb. operating pressure; three Webster feed water heaters, each with capacity to heat 3350 gal. per minute from 90 to 160 deg.; three Epping Carpenter boiler feed pumps 16 x 9 x 18 in. The hydraulic equipment is as follows: One 14-in. Duplex Worthington steam service pump (used as spare); three 6-in. Allis-Chalmers centrifugal service pumps; eighteen 10 x 6 x 16 high pressure mine water pumps; seventeen 12 x 7 x 16 low pressure mine water pumps, both Epping Carpenter manufacture; eight mine water heaters designed to use live steam direct for heating. The normal operation of the water system is as follows:

The service pumps deliver to the feed water heater, thence to the feed pumps and also the low pressure mine pumps, thence through the mine water heater to the high pressure mine pumps, and thence to the sulphur wells. By-passes are arranged so as to make the piping system flexible. Two radial brick stacks 200 ft. high by 13 ft. in diameter built by the M. W. Kellogg Co. complete the power house equipment. A water reservoir of 240 million gallon capacity assures tiding over the Texas drought. A system of shallow wells has been bored as an additional source, should the Colorado River stay dry for any unusually long period.

Oil is received from tank cars, pumped to two steel storage tanks 114 ft. 6 in. in diameter by 30 ft. high. From there it is pumped to two underground concrete storage tanks, each having 1200 bbl. storage capacity, whence three 7½ x 5 x 10 steam pumps deliver the oil direct to the boilers. These tanks and pump house are located about 140 ft. from the pumping station. Two oil heaters for warming oil up to the necessary temperature before combustion are located in the pumping station. All oil tanks and outside oil pipes are provided with steam pipes or coils in order to keep the oil sufficiently warm to flow in cold weather.

#### MACHINE SHOP AND WAREHOUSE

The machine shop is approximately 116 x 75 ft.; the warehouse 170 x 60 ft. The machine shop has one 19-in., one 16-in. and one 12-in. lathes, one 25-in. shaper, one 12-in. pipe threader, one 6-in. and one 2-in. pipe machines; one 26-in. drill, one 20-in. drill and one 14-in. sensitive high speed drill; one woodworker including planer and saw. Each principal machine is driven by individual direct connected motor. One corner of the machine shop is partitioned off for a blacksmith shop and contains a 1600-lb. steam hammer, forge, anvil and tool grinder.

#### Industrial Gas Masks

The Bureau of Mines announces that it is making a preliminary investigation of gas masks with a view to establishing a list of approved devices for use in the mining and allied industries. After the preliminary investigation the Bureau will issue a schedule of tests which apparatus must meet in order to gain the approval of the Bureau of Mines. These investigations will be conducted at the Bureau's Pittsburgh Station by men who have had intimate connection with the development of mine-rescue apparatus and gas masks.

### Gold and Silver Produced in the United States in 1918

The Bureau of the Mint and the Geological Survey have issued the following joint preliminary estimate of the production of gold and silver in the United States during the calendar year 1918:

State or Territory	Gold		Silver	
	Fine Oz.	Value	Fine Oz.	Value <sup>1</sup>
Alaska.....	440,622	\$9,108,500	796,836	\$796,836
Alabama.....	36	700	2	2
Arizona.....	278,647	5,760,200	6,771,490	6,771,490
California.....	832,389	17,207,000	1,555,417	1,555,417
Colorado.....	621,791	12,853,500	6,982,313	6,982,313
Georgia.....	169	3,500	41	41
Idaho.....	30,764	636,000	10,188,056	10,188,056
Illinois.....	0	0	8,939	8,939
Maryland.....	0	0	164	164
Michigan.....	0	0	491,939	491,939
Missouri.....	10	200	40,948	40,948
Montana.....	153,375	3,170,600	15,341,793	15,341,793
Nevada.....	322,276	6,662,000	10,113,405	10,113,405
New Mexico.....	30,871	638,200	763,758	763,758
North Carolina.....	38	800	9	9
Oregon.....	60,951	1,260,000	150,207	150,207
Philippine Islands.....	44,202	913,700	12,597	12,597
South Dakota.....	328,305	6,786,700	165,865	165,865
Tennessee.....	263	5,400	131,931	131,931
Texas.....	5	100	612,436	612,436
Utah.....	152,018	3,142,500	13,439,811	13,439,811
Vermont.....	47	800	5,117	5,117
Virginia.....	20	400	2,967	2,967
Washington.....	16,556	342,300	302,446	302,446
Wyoming.....	18	400	719	719
Total.....	3,313,373	\$68,493,500	67,879,206	\$67,879,206

<sup>1</sup> Valued at the Government buying price of \$1 an ounce.

These figures, compared with those showing the production in 1917—gold, \$83,750,700; silver, 71,740,352 ounces—indicate a reduction in the output of gold of \$15,257,200 and in that of silver of 3,861,156 ounces. The output of gold in 1918 was the smallest in twenty years and that of silver was the smallest since 1913.

### Ecuador Establishes Crude-Salt Monopoly

The Minister of the Treasury of Ecuador has just published the text of the law making effective the salt monopoly established there by the legislative decrees of Oct. 13, 1916, and Sept. 26, 1918, reports Consul General Goding. This law, after stating that sea salt will be handled exclusively by the Government and consequently will not be let out to the highest bidder, also that proprietors and owners of salt mines may sell only to the Government, fixes the price which the Government will pay and for which it will sell salt in the republic. The law also limits the amount of salt that will be sold to any one person.

Importation of foreign salt is prohibited, "except in case it should appear for any reason to be impossible to supply the republic with salt from the national mines. This proscription does not apply to refined salt, unless the Government should establish refineries for that purpose."

The Executive, however, is authorized to introduce the refining of salt into the republic, investing for this purpose such sums as may be necessary. The law provides that the Executive shall fix the price of the refined salt, taking into account the expenses incurred in refining it.

### Resumption of Trade With Serbia and Rumania

By a recent ruling of the War Trade Board, all persons in the United States are authorized, subject to the rules and regulations of the War Trade Board and the import regulations of these countries, to trade and communicate with persons residing in Serbia and Rumania.



## Aids to Foreign Trade in the Chemical Industry

**M**ARKED activity has been displayed by the Bureau of Foreign and Domestic Commerce in its efforts to promote foreign trade. Through the appropriations made by Congress this branch of the Department of Commerce, under Secretary William C. Redfield's direction, has broadened out to all parts of the world and has sent trade commissioners, as they are known, to all countries to glean such information as will constitute reports that should be invaluable to American

junction with the information shown thereon, there is also published a list of the publications, which can be obtained by writing to any of the district offices or to Washington, specifying the line of information sought.

Recent appropriations have been granted to this department and the service will still be carried out; and through their medium, known as the *Commerce Reports*, issued daily, they are striving to keep the American public informed on the real conditions as they exist.

It is surprising to learn how little is generally known of the fact that this information has been available



manufacturers along various lines that have been developed in this country, particularly during the war period.

Now that priorities have been raised and appropriations have been made by the operating division of the Shipping Board, particularly for South America, there will be a tendency toward improvement in the export trade.

Many manufacturers throughout this country have been perplexed as to the best method of securing export trade in their particular line. Herewith is published a chart that has been issued by the Bureau of Foreign and Domestic Commerce, dealing with foreign trade promotion, which, if closely studied, will show the information that is available from our own Government that should furnish a general knowledge of the subject, and serve as a guide to the prospective market. In con-

from the Government agencies, and it is with a view of furnishing this information and encouraging co-operation with this department of our Government that **CHEMICAL & METALLURGICAL ENGINEERING** is presenting this chart. This information is available to those interested in obtaining it.

### British Import Restrictions

All restrictions limiting importation of sirup, molasses and like articles will be removed Feb. 24, 1919.

The following articles will again be on the list of prohibited imports after Mar. 1, 1919, and can then be imported only under special license:

Aluminium and manufactures of aluminium, including aluminium powder; cement, fatty acids, methyl alcohol, salt, soap, weighing machines, scales and balances of all descriptions.—W. T. B. R. 557.



## Acetone

BY H. P. BASSETT, PH.D.

FOR several years previous to the war the amount of the acetone made in this country was small, the larger part of our gray acetate of lime being exported to foreign countries, to be used in various industries, like synthetic indigo, acetic anhydride, acetone and other products of a lesser volume, as asperin and the like, in the drug trade.

Practically all of the gray acetate of lime produced in this country at that time was obtained from the distillation of wood, to produce charcoal for the charcoal iron industry, and was necessarily dependent on the sale of the charcoal to make the industry pay. For this reason, shortly before the outbreak of the war, many of these plants were shut down, but on the outbreak of the war both charcoal iron and gray acetate of lime came into great demand. Every one is familiar with the extreme test the English Government underwent in its search for acetone to use as the solvent in the manufacture of cordite. Several new plants were built and old ones enlarged to produce the acetone which had been demanded over night, as it were.

New sources of this material were developed, such as the fermentation of molasses to alcohol and the alcohol to acetic acid, the fermentation of kelp and the transformation of acetate into acetone and similar solvents.

The almost exclusive use of acetone during the war was in the manufacture of military explosives, especially for the English Government, and consequently any other use was practically prohibited.

In this search for acetone, one source of this material seems to have been overlooked, namely, that from wood, sugar, gums, etc., mentioned by Freny. (Ann. Chim. 59-7). Freny mentions a source of acetone from the distillation of the above products, especially wood, with eight parts of lime. This does not look attractive on account of the large amount of lime required, but several years ago I had occasion to investigate this problem and much less lime is needed, if the proper conditions are observed.

In order to obtain the best results the mixture of lime and sawdust or wood in a similar state should not be heated too rapidly, requiring about ten hours to reach the maximum heat, and again the vapors should be removed from the retort as quickly as possible after they are formed. This may either be done by steam or an inert gas, such as carbon dioxide, preferably steam. Under these conditions a good yield of acetone and higher ketones can be obtained with 24 parts of lime to one part of dry wood.

Under the above conditions a yield of 26 per cent of acetone and mixed ketones can be obtained, and as the higher ketones are now in demand and in many respects for certain purposes it is desired to have a solvent of the nature of acetone and one that is not so extremely volatile, these higher ketones are preferable. For many purposes, like films for aeroplane dope, etc., where the evaporation of the solvent is wished to be retarded, the higher ketones find an extended use.

This, however, as a permanent industry has the same disadvantages as that recently mentioned in one of

the late numbers of this journal in an article by Tomlinson, entitled "Wood-Waste as a Source of Ethyl Alcohol."

It is entirely possible to use sulphite waste liquors in this same manner, as they can be easily evaporated to a thick or rather thick consistency and then by adding the lime will dry this liquor to the point where it can be dried on a chain drier, drum drier or, better still, in a rotary drier if knockers are provided to keep it knocked from the sides.

The uses for acetone and higher ketones have been greatly extended during the past four years and promise to afford many new outlets for such solvents as, for instance, in the waterproofing of cloth and artificial leathers.

## Electric Steel Castings

WHEN the modern motor truck first made its appearance in the business world, it was in many ways still a rather crude affair. But constant improvements and changes have developed it, until to-day it is one of the most effective methods of commercial transportation. One of the latest of these improvements has been the invention of a one-piece steel wheel for motor trucks. The constantly increasing weight of loads and the high speed which have been demanded of the motor truck proved too great a strain on the old-style wheel of the built-up type. A loose spoke on a motor truck wheel was found to be a much more serious matter than



ONE-PIECE STEEL WHEEL FOR MOTOR TRUCKS

it was in the days of the horse and wagon. "Flats" which developed were very destructive of bearings and axles and, in fact, had a destructive effect on the entire structure of the truck.

Automotive engineers, who were quick to see this trouble, studied the matter carefully. It was universally accepted that a metal wheel was the proper type

<sup>1</sup>CHEMICAL & METALLURGICAL ENGINEERING, Vol. 10, No. 7, Oct. 1, 1918.

for motor truck use and would meet the great need of strength. As a result numerous styles and types of metal wheels were evolved in an effort to build a wheel which would answer every requirement of truck haulage. While these different types of metal wheels were each an improvement in certain ways over the old-style built-up wheel, they were lacking in two or more of the essential qualities.

The ultimate wheel, which answers every requirement and which is finding great favor among manufacturers of motor trucks and among truck owners, is the Dayton steel wheel. This is a one-piece wheel of electric furnace steel. It at once overcomes any possibility of loose spokes, because of its one-piece construction. Spokes and rim are hollow and of uniform thickness, which result in lightness of weight that is astonishing. As will be noted from the illustration herewith, it has also a peculiar construction in its odd number of spokes and sweeping curves. This design has the effect of dissipating excessive road shocks so that they do not reach the axle, but are distributed throughout the wheel, which greatly prolongs the life of the truck.

Recent Government tests have proved that the Dayton steel wheel has remarkable strength and resiliency. And the fact that Government experts were impressed with the advantages of this style of wheel is evidenced in the specification of steel wheels of this type in the construction of motor trucks for war work.

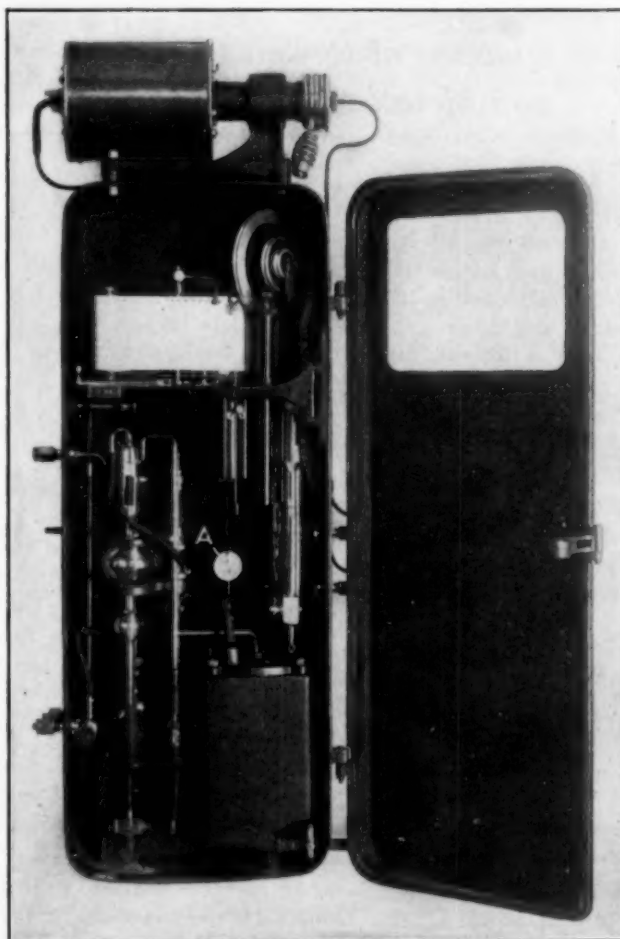
An extensive national advertising campaign which is now being conducted on this wheel is arousing a great deal of interest among manufacturers of motor trucks and among users. There is bound to be a wide use of the Dayton steel wheel for motor trucks.

## Hydrogen Recorder

**T**HE Harger hydrogen mono recorder is adapted for almost all industrial purposes, as a variety of ranges are provided. Similarly to the Mono CO<sub>2</sub> recorder, an auxiliary apparatus which also analyzes automatically carbon monoxide, methane, carbon dioxide and oxygen can be attached to this instrument.

Briefly the principle of the hydrogen mono is as follows: The gas is trapped off in a 100 cc. burette by means of a falling mercury column. The motive power of the instrument can be either water or compressed air. When the sample is thus trapped off, it passes into an electric oven in which there is inserted a cartridge which at high temperature oxidizes the hydrogen in the gas to water. This water vapor follows the gas sample, is condensed and removed. Thus contraction is brought about in the gas mixture and as at the same time the original volume is altered according to the amount of hydrogen absorbed, the change of this volume is recorded in the usual manner on a sixty days' chart of such width that each per cent and fraction thereof can be plainly read with accuracy. The electric oven requires about 200 watts and is made for a voltage of 110.

The oxidation cartridge is gradually reduced and arrangements are made for convenient replacement. The cartridge may also be regenerated by heating. Its durability depends upon the amount of carbon dioxide and methane in the gas analyzed. The smaller the amount of hydrogen the longer it will last, and on an average of 10 per cent of hydrogen and a speed of



HYDROGEN MONO RECORDER

thirty analyses per hour the cartridge will retain its full strength for about two hundred hours. There is no other maintenance cost connected with the instrument and it should, therefore, be considered as a very important addition to the chemical plant equipment put out by the F. D. Harger Co. of Buffalo.

## Ordnance Scrap Material for Sale

The War Department authorizes the following from the office of the director of sales:

The estimated value of ordnance scrap material on hand Dec. 31, 1918, by classes has been reported by the stores and scrap section of the Ordnance Department to the director of sales. The list is as follows:

	Pounds
Aluminum scrap, all kinds.....	46,608
Brass scrap, all kinds.....	5,842,351
Cupro-nickel scrap, all kinds.....	781,392
Copper scrap.....	691,580
Machine shop borings and turnings.....	9,714,139
Steel, heavy melting, scrap.....	20,771,061
Steel, low phosphorus, scrap.....	5,988,477
Nickel steel, heavy melting, scrap.....	5,518,359
Nickel steel, borings and turnings.....	15,654,919
Cast and malleable iron, scrap.....	13,692,718
High speed borings, turnings, scrap tools.....	63,365
Mixed and miscellaneous iron and steel scrap.....	5,195,748
Miscellaneous scrap, consisting of rags, waste paper, etc.....	803,956
Lead dross scrap.....	153,005
Lead scrap.....	322,355
Brass ashes and sweepings.....	1,067,571
Burlap.....	256,063
Spent acid.....	1,495,250
Amatol.....	269,847
Ammonium picrate.....	5,000
Tetryl.....	18,660
<b>Total.....</b>	<b>88,352,324</b>

It should be noted, however, that scrap inventories vary every day.

## Synopsis of Recent Chemical and Metallurgical Literature

**Slagging Gas Producer.**—A description of the slagging gas producer working on coke was recently published in the *Iron and Coal Trades Review* from *Stahl und Eisen*. It is a short blast furnace, with a relatively deep hearth, 5 ft. 3 in. in diameter, a shallow bosh, and a vertical shaft, the whole being 16 ft. 5 in. high. Sufficient high-iron slag from a mixer or a basic open-hearth is charged with the coke to be gasified in order to properly slag its ash—30 tons of coke being charged in 24 hours. The blast is warmed in a heat interchanger to 70 deg. C., and blown through water-jacketed tuyeres at 15.7 in. water pressure. Slag is tapped at four-hour intervals, while 8 to 12 hours are required to accumulate 8 in. of iron in the bottom of the hearth. The iron produced contains 8 to 10 per cent of manganese and somewhat more phosphorus. The top of the producer is covered by a flat dome of refractory brick, pierced by numerous peep holes. In operation no poking or stirring is necessary, the gas leaves the shaft at about 700 deg. C., is practically free from tar, and has the following analysis:

CO <sub>2</sub> .....	0.3 to 0.7
CO.....	33.0 to 33.5
CH <sub>4</sub> .....	1.2 to 1.3
H <sub>2</sub> .....	0.1
H <sub>2</sub> O.....	12 g. per cu.m.
S.....	0.25

The coke contained 84 to 88 per cent carbon, with a calorific power of 7000 calories, while the yield of the above gas amounted to about 175,000 cu.ft. per British ton. This producer has been operating satisfactorily at the Georgesmariehütte for over two years, working for thirteen months continuously before the lining of the hearth had to be removed.

**The Elastic Indentation of Steel Balls Under Pressure.**—C. A. BRIGGS, W. C. CHAPIN and H. G. HEIL of the Bureau of Standards have studied the effect of pressure on the steel balls and rounded-end length standards used for munition gages. For the light pressures studied they conclude that the deformation of the ball-surface not actually in contact is very small. They therefore confined their attention to measuring the area of contact made by flat and spherical surfaces, one of which was of transparent glass. This area was the central spot in the system of Newton's rings formed in each case. From experimental and theoretical considerations, the following general formula was derived which gave very excellent results:

$$\Delta G = 0.518 P^{\frac{1}{2}} \left[ \frac{G_1 + G_2}{G_1 G_2} \right]^{\frac{1}{2}} \left[ \frac{1}{E_1} + \frac{1}{E_2} \right]^{\frac{1}{2}}$$

Here  $\Delta G$  = the mutual indentation between the surfaces in contact;  $P$  = the pressure acting between the two surfaces;  $G_1$  and  $G_2$  = the radii of curvature of the two surfaces;  $E_1$  and  $E_2$  = the indentation moduli of the surfaces  $G_1$  and  $G_2$ .

The indentation modulus is given by the expression

$$E = \frac{E}{1 - u^2}$$

where  $E$  = Young's modulus;  $u$  = Poisson's ratio.

The case of the indentation of steel balls between flat steel surfaces appeared to have the most immediate

importance. Consequently the following special formulae were derived, using tabular values for the physical constants involved. For precision work it would of course be necessary to determine Young's modulus and Poisson's ratio for the materials in hand, as well as to check the

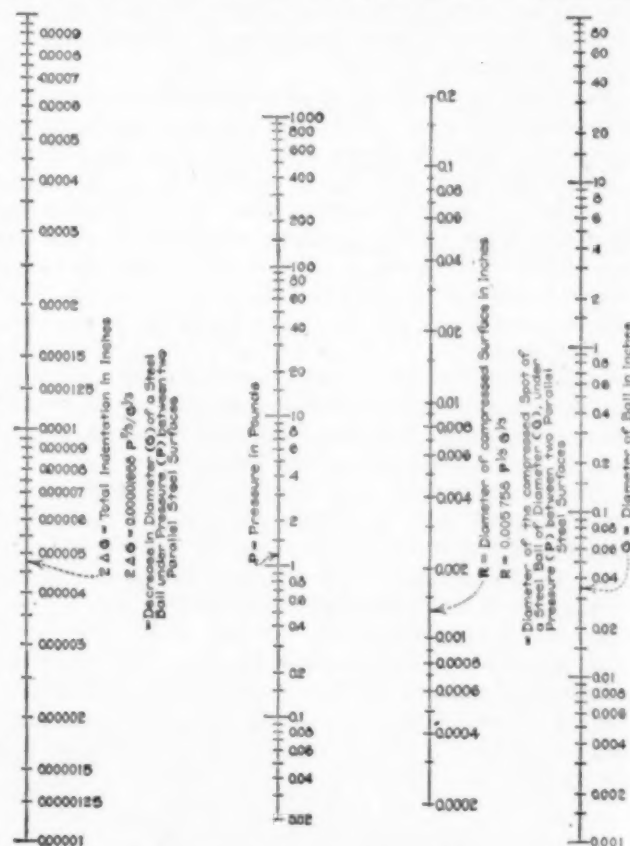


FIG. 1. INDENTATION OF STEEL BALLS

extrapolation of the general formula from the very low pressure used by the authors (20 pounds pressure on  $\frac{1}{4}$ - and 1-in. balls) to the region in use.

Indentation for Steel Balls Between Flat Steel Surfaces:

$$2\Delta G = 0.000166 \frac{P^{\frac{1}{2}}}{G^{\frac{1}{2}}}$$

where  $2\Delta G$  is given in inches.

Diameter of Area of Contact Between the Surface, Steel Against Steel:

$$R = 0.00576 P^{\frac{1}{2}} G^{\frac{1}{2}}$$

where  $R$  is given in inches.

Average Pressure Over the Area of Contact, for Steel Against Steel:

$$S = 38.400 \frac{P^{\frac{1}{2}}}{G^{\frac{1}{2}}}$$

where  $S$  is given in pounds per square inch.

Fig. 1 gives an alignment chart for graphical solution. A straight line drawn between any two points determines corresponding values on the intercepts with the other axes.

**Divorce of Pearlite After Cold Working.**—J. H. WHITELEY read a paper before the May meeting of the Iron and Steel Institute (British) giving the results of a research started by the observation that the color-carbon given by a cold-worked sample is considerably higher than the determination on the same metal in



an unstrained condition. A piece of eutectoid steel showing very fine pearlitic laminations was cold-hammered from  $\frac{1}{2}$ -in. square to  $\frac{1}{8}$ -in. square. After annealing at 650 deg. C. for one hour it was found that almost the whole of the cementite had been divorced and now appeared in small spheroids. In a fresh piece the laminations showed a decided tendency to break up after annealing for 15 minutes at 500 deg. C., while 15 minutes at 600 deg. caused almost complete divorce. Considerable difference in speed of the transformation in various portions of the areas was noticed, however. In order to discover the relation of the degree of deformation to the speed of spheroidizing, a  $\frac{1}{2}$ -in. bar was struck lightly twice, reducing its cross-section to about  $\frac{7}{16}$  in. Two hours' annealing at 680 deg. showed only traces of the original laminations. The authors suggest that this acceleration of divorce on annealing may prove to be a delicate test for small amounts of strain in pearlitic steel. Coarse pearlite in low carbon steels gave the same results as above. The spheroidal pearlite obtained after cold working and annealing cannot be distinguished from the "granular pearlite" of quenched and tempered steels; the two probably are identical in structure.

As is well known, to bring about this result in unstrained steel requires many days' heating. It is not thought that the cold working ruptures the cementite laminae, thus presenting fragments which later ball up by surface tension. H. LeChatelier's suggestion that the bent laminations are in a state of elastic tension, which state of strain has been shown to increase the solubility of crystals, may have considerable bearing on determining the points where the cementite layers first part.

Again, cementite films are known to be in a metastable condition. Goerens has also shown that the strain in iron due to cold work is removed rapidly at the same temperature at which rapid divorce starts. It is very possible that the slight changes in volume, crystallization and surface tension accompanying relief of internal strain may disturb the metastability of the cementite laminae, resulting in accelerated spheroidizing.

Finally, the author suggests that the false stability of the films of cementite is disturbed by working, and it breaks up much as does a thin cylindrical stream of water issuing from a tap when subjected to slight vibrations.

**Heat-Treating Shells.**—A paper was read before the Steel Treating Research Society at Detroit in March, 1918, by J. M. HALL, giving the methods of heat-treating shells used at the Hamilton Steel Wheel Co. of Hamilton, Canada. The chemical and physical requirements for the principal shells are:

	16-Lb. British Shrapnel 3½-In. Blanks Finished Shell	6-In. High Explosive
Carbon.....	0.48 to 0.60	0.40 to 0.55
Manganese.....	0.5 to 1.0	0.60 to 1.0
Silicon.....	Under 0.3	0.15 to 0.35
Phosphorus.....	Under 0.06	0.0 to 0.05
Sulphur.....	Under 0.05	0.0 to 0.05
Elastic limit, lb.....	42,600	80,700
Ultimate, lb.....	78,500	126,000
Elongation, per cent.....	20 in 2 in.	8 in 1 in.

After finish-boring and rough-turning the rolled bars used for these shells they are ready for the quenching operation. Heating is effected in an oil-fired furnace with a combustion chamber underneath the hearth. The shells are ranged into the furnace on end, and slowly

heated to from 1500 to 1700 deg. F. depending upon the carbon content. The hot shells are then quenched in a soluble oil. A very handy tank for this operation, especially in automatic furnaces, consists of a round bath, 7 ft. in diameter and 3 ft. deep. Inside this bath is a turntable containing a series of baskets into which the hot shells are dropped and remain upright, base downward. The turntable slowly rotates, and the quenched shell is withdrawn on the opposite side after immersion for about 6 minutes. The average oil temperature is kept below 200 deg. F. by circulation over cooling coils. After quenching, the shells are drawn in a similar furnace to a temperature of from 950 to 1350 deg. (depending upon the carbon content) and air cooled. The open end is immediately heated to 1100 deg. F. in a metal bath, "nozed," and immediately buried in flake mica for slow cooling.

High explosive shells are forged from open-hearth steel blanks. For instance, a 6-in. shell is made from a blank cast on end in a preheated cast iron mold with a hot top,  $6\frac{7}{8}$  in. in diameter, tapering at the bottom. The metal is poured slowly through a 1-in. nozzle to minimize piping. The hot castings are stripped, 20 per cent of the top of the blank is cut partly through and then broken. This discards the piped top and gives a fracture for inspection. Forgings from properly cast blanks give as good results as those from rolled bars. The bars are heated for forging in a flat-hearth, oil-fired furnace, 7 ft. by 14 ft. in dimensions, with a capacity of 100 6-in. shells. It requires 2½ hours to complete a furnace cycle, the steel being held at the correct heat (1800 to 2000 deg. F.) at least 15 minutes, since it is important that the interior of the bar attain the correct temperature and that the forging be done on a cooling piece of metal. Forging is done in various ways: The billet may first be pressed into the die—an operation called "bunting"—pierced large, and the whole then drawn through a succession of rings to reduce the size to the proper dimension. As an alternative method, the shell may be bunted and pierced to size, or finally a round billet may be pierced to size in one operation. The last method is now usual practice in Canadian shops and apparently gives as good results as the two others. After forging, the temperature is about 1700 deg. F., and the shell is cooled on a slow-moving conveyor leading through a draft tunnel. The time required to reach a temperature of 800 deg. F. is from one to two hours, depending upon the carbon content of the shell. About 2 per cent of the forgings are then selected for physical tests, and test bars are cut from the base end by an acetylene torch.

If the shells are rejected as having too high an ultimate strength they are annealed to 1600 deg. F. and allowed to cool in the furnace. This practice will reduce the ultimate of a 60-point steel 7000 pounds and increase the elongation 6 per cent. On the other hand, low carbon steels which are rejected for opposite causes are heated to 1550 deg. F., placed on rollers under three pipes blowing air at 12 oz. pressure upon them through a number of holes. The shells are cooled to 800 deg. F. in 7 minutes, while the ultimate strength is raised 8000 pounds with a corresponding reduction of the elongation of only 0.6 per cent. In this manner the final rejections at the plant in question have been reduced to less than 1 per cent.

## Book Reviews

**SCRAP METALS.** By George H. Manlove and Charles Vickers. 278 pages; price \$2.00. Cleveland, Ohio: The Penton Publishing Co.

The authors point out that although scrap occupies a place as one of the most important raw material departments of the iron and steel world, the scrap industry has had no literature. They state that the present effort to present a broad review of the business originated in a series of articles recently printed in the *Daily Iron Trade and Metal Market Report*.

The book is divided into two parts, the first of which, by Manlove, treats of steel and iron scrap, while the second, by Vickers, treats of non-ferrous scrap. In the first section of the book the author discusses the importance of the scrap industry and throws much light on the conventional classification of scrap, including specifications for scrap intended for various special purposes; methods of collection as practiced by the producers in industries in which scrap metals are by-products, and by scrap dealers, large and small, are described in outline; and an account is given of the methods of organization in current use as well as conditions governing price regulation. These features are sufficiently developed to make the book extremely useful to all persons who are either directly or indirectly interested in the purchase or sale of scrap.

In this country, until within recent years, waste has proceeded in many industries without hindrance. Since the war the widely advertised salvage operations on warfronts by the belligerent Powers have aroused new interest in the possibilities of such operations as applied to American industries. As a consequence there are now appearing in trade journals detailed descriptions of the procedure at present followed in certain plants. This book gives an interesting summary of some of the efforts which have been made in this country, especially by railroad companies. This account should make the book well worth reading for persons not especially interested in scrap because of the suggestions for the reclamation of waste which can often be carried over bodily to other industries. The author has succeeded in presenting his subject in such an interesting manner that reading for this purpose by such persons will not be difficult.

The second part of the book, which deals with non-ferrous scrap metals and alloys, is briefer, but, like the first part, contains much valuable information and suggestions concerning the reclamation and disposal of such materials.

Both of the authors are to be congratulated on producing a useful book on this important but hitherto neglected subject.

## Personal

MR. C. N. BARNEY has been appointed representative for the Worthington Pump & Machinery Corporation of Virginia at the New York office, 115 Broadway.

PROF. W. D. BONNER, professor of chemistry at the University of Utah, is also acting as consulting chemist to the U. S. Bureau of Mines and is in charge of laboratory investigation on oil shales.

MR. ARTHUR F. BRAID has been appointed sales manager of the metal and alloy department of the Metal & Thermit Corporation, New York City.

MR. FREDERICK K. BRUNTON is now with the Phelps-Dodge Corporation's smeltery at Douglas, Ariz., having recently left Morenci, Ariz.

MR. F. W. BUNYAN is now chief chemist of the Noble Electric Steel Co., Herault, Calif.

DR. E. E. CHARLETON, assistant in chemistry at the University of Illinois, has resigned that position to accept one

with the du Pont Powder Co. of Wilmington, Del. He will be succeeded by Lieut. J. B. Brown, who has recently been released from military duty at the Chemical Warfare Service, Washington, D. C.

CAPTAIN R. L. KRAMER, C.W.S., who has been officer in charge of the men in uniform at the War Laboratory, Johns Hopkins University, Baltimore, Md., has been released from service and has entered as a graduate student in chemistry at Johns Hopkins.

MR. C. E. LITTELL has resigned his position as chief chemist of the Providence Gas Co., to take charge of the heating of the new Koppers by-product coke and gas ovens. Before going to Providence, Mr. Littell was connected with the United Gas Improvement Co. of Philadelphia, Pa.

MR. J. J. MCKEE has severed his connection with the C. A. Dunham Co., Marshalltown, Ia., to accept a position with the Machinery Utilities Co., 501 Fifth Ave., New York City.

MR. H. C. PARMELEE, editor of *CHEMICAL & METALLURGICAL ENGINEERING*, was elected an honorary member of the Teknik Club of Denver at a meeting held on Jan. 14. Mr. Parmelee was secretary of this society for some years, at which time he was Western Editor of this journal with an office in Denver.

LIEUTENANT LLOYD VAN DOREN, C.W.S., who was formerly in General Sibert's office in Washington, D. C., has accepted a position as Carnegie assistant under Mr. Frazer of the Johns Hopkins University, Baltimore, Md., and will work for the remainder of the year on osmotic pressure.

CAPTAIN GERALD L. WENDT, who was discharged from the Chemical Warfare Service on Dec. 1, has taken up his duties again as assistant professor of chemistry at the University of Chicago and as a member of the editorial board of the *Bulletin of the Chicago Section of the American Chemical Society*.

MR. HARRY J. WOLF of the Malm-Wolf Co. has been appointed consulting mining engineer in the U. S. Bureau of Mines.

## Current Market Reports

### The Non-Ferrous Metal Market

*Saturday, Feb. 8.*—Liberal price concessions have been made but no heavy buying has resulted.

**Aluminium:**—The Government prices on ingots 98 to 99 per cent Al are \$660 a ton f.o.b. plant in 50-ton lots; \$662 down to 15-ton-lots; and \$666 down to 1-ton lots, which prices will continue until the first of March. Prices per pound for small lots vary from 40c. to 45c.; sheet aluminium, 18 ga. and heavier, 42c.; powdered aluminium, 100 mesh, 70c.

**Antimony:**—Antimony continues to sell at from 7½ to 7¼c. per lb. with no changes in view.

**Copper:**—The situation in the copper market is extraordinary. Sales at 18½c. have been made, but stocks are still accumulating.

Copper sheets, hot-rolled.....	lb.	\$0.29 — \$0.33
Copper sheets, cold rolled.....	lb.	.30 — .34
Copper bottoms.....	lb.	.37 — .41
Copper rods.....	lb.	.25½
Copper wire.....	lb.	.23
High brass wire.....	lb.	.24½ — .26½
High brass sheets.....	lb.	.24 — .26
High brass rods.....	lb.	.23½ — .25½
Low brass wire.....	lb.	.26 — .28
Low brass sheets.....	lb.	.26½ — .28½
Low brass rods.....	lb.	.27 — .29
Brazed brass tubing.....	lb.	.35 — .37
Brazed bronze tubing.....	lb.	.40 — .42½
Seamless copper tubing.....	lb.	.35 — .37
Seamless bronze tubing.....	lb.	.40 — .42½
Seamless brass tubing.....	lb.	.34 — .36
Bronze (gold) powder.....	lb.	1.00 — 1.75

**Lead:**—This market is stagnant even at 5c. quotations, but the validation of informally made war contracts will soon reawaken activity.

**Tin:**—The U. S. Steel Products Co. has liquidated 3000 tons of the original 10,000-ton stock at the 72c. basis. It is expected that it will take several months to dispose of the remaining stock, after which prices will fall sharply.



**Zinc:**—Spelter has fallen with spot New York at \$135 per ton and futures at \$128. East St. Louis spot is quoted at \$128.

## OTHER METALS

Bismuth.....	lb.	\$3.50 — \$3.65
Cadmium.....	lb.	1.50 —
Cobalt.....	lb.	2.50 — 3.50
Magnesium.....	lb.	1.75 — 2.10
Mercury.....	75 lb.	95.00 —
Mercury.....	lb.	1.95 —
Nickel.....	lb.	.40 — .45
Tungsten.....	lb.	Nominal
Iridium.....	oz.	175.00 —
Palladium.....	oz.	135.00 —
Platinum.....	oz.	105.00 — 108.00
Silver.....	oz.	1.01 —

## The Iron and Steel Market

Any doubt that may have existed as to the character of the iron and steel market, for the first half of 1919 at least, has now been dispelled by the continued inactivity and by the failure of any signs to develop that favorable conditions are on the way.

During the latter part of January buying of steel products was at a slightly increasing rate, though at the best it was light. In the past fortnight the market has been even more stagnant than formerly.

Steel mill operations have been at an average of about 50 per cent of capacity in the case of the independents, while the Steel Corporation subsidiaries have been operating at about 85 per cent. The difference in rates is not to be ascribed to difference in the character or volume of business on books, but is rather to be attributed to a difference in policy. The independents are making only the material for which they have shipping orders, while the Steel Corporation is putting a considerable portion of its output into stock. At the pipe, wire, sheet and tin plate mills there is storage capacity equal to from four to six weeks of production, and for these products as well as for bars, shapes and plates the Steel Corporation has a line of warehouses from Boston to Chicago and New Orleans. By the close of the war stocks at these warehouses had been reduced to almost nothing. Apparently the Steel Corporation is actuated not so much by a desire to have a reserve of material against increased demand in future as by a desire to give employment to its men, preventing discontent and discouraging the spread of union sentiment, for unionization of the steel industry, on account of its tendency to restrict output, would be extremely harmful.

## ECONOMIES IN PRODUCTION

While there is economy, as to production cost per ton, in operating at 85 per cent rather than 50 per cent, not a great deal of attention is paid to economies as disclosed merely by the cost sheet, for matters of policy are involved. Thus with basic pig iron held at \$30 at furnace and with heavy melting steel available at \$16 a ton or thereabouts it would undoubtedly be cheaper to use large percentages of scrap and cut down the consumption of pig iron, and this would apply to a great extent even to the self-contained interests, whose production cost of pig iron is to be considered, rather than the open market price, yet there is no evidence that the proportions of scrap used have increased. Scrap is, indeed, a drug on the market and dealers doubt whether the mills are using as large a percentage as formerly in their open-hearth charges.

## CHARACTER OF DEMAND

Demand for steel products is entirely along lines of everyday consumption, orders involving permanent construction or investment works being very conspicuous by their absence. Manufacturing consumers generally, making various wares practically for sale over the counter, are buying in a moderate way, but with great conservatism and evidently with a view of maintaining stocks at the lowest possible point. This is true also of jobbers, who buy only for immediate turnover. The automobile makers are taking steel very freely and already have almost attained their former rate of consumption. The buying of electrical sheets is almost entirely confined to material for automobile equipment, indicating that electric motors and generators of

large size are in no request, a condition that does not obtain when there is new construction work in progress or in sight, such as involves demand for structural and cognate forms of steel. The agricultural implement makers are taking steel at a fair rate, evidently in expectation of at least moderate demand from the farmers, and steel producers are in expectation of the farmers buying fairly well of fence wire, wire fence, wire nails and sheets, though thus far such buying has been very far from heavy.

## BARRIERS TO ACTIVITY

Conditions in the steel trade are not peculiar to that industry, but are to be found more or less in industrial activity generally. The barriers to activity apply in particular to works of construction, of the investment character, and as steel passes largely into such permanent works, rather than into items of current consumption, the condition is most pronounced in steel.

The two great barriers to activity, of course, are the failure of prices, or costs, to adjust themselves to prospective conditions, and the menace of bolshevism. Both are equally deterrent influences to the prospective investor, who does not wish his investment to be destroyed or have its earning power reduced, as a spread of bolshevism would threaten, while a decline in the cost of construction work would write a depreciation upon any work completed at the higher cost, and thus tend to decrease its earning power.

The two barriers, high costs and the bolshevist menace, are closely interwoven. The bolshevist menace discourages attempts to reduce costs, although in the long run that would be to the advantage of labor, as it would produce more work.

## STEEL INDUSTRY HELPLESS

In the circumstances the steel industry is helpless. It cannot bring about better conditions, for the barrier to steel consumption is neither the character nor the price of the steel that is offered for sale. It is the cost of putting steel into consumption, and the uncertainty of reward to the investor after he had put the steel into employment, that prevents buying. It is true that current prices for steel products are too high to furnish a proper basis for a widespread demand, but adjustment in that matter can be effected when it becomes apparent that the need is arising. To cut prices now, little or much, would not increase demand for a time at least, and would indeed at the outset prove discouraging to buyers. With reduced operations mills need very considerable profits per ton to maintain their position, and for the mills to lose money would benefit no one. Of course the salesmen of the steel companies endeavor to prove to customers that steel prices are unlikely to come down much if at all and indeed really simply can't come down much, but such arguments are of only temporary use. There can be scarcely and doubt that eventually, and before there is such a demand for steel as to engage the full mill capacity, there will be very considerable declines in steel prices. The pre-war average will not be attained, but more than half the distance from Government prices of 1918 to the pre-war average will in all probability be traversed.

## PRICES FIRM

Finished steel prices are firmly maintained at the declines that became effective in December, from the Government limits: Plates, 3c.; shapes, 2.80c.; bars, 2.70c.; grooved steel skelp, 2.70c.; blue annealed sheets, 10 gage, 3.90c.; black sheets, 28 gage, 4.70c.; tin plate, \$7.35; standard steel pipe, 54 per cent basing discount. Wire remains at 3.25c. and wire nails at \$3.50, the Government limits. Billets are \$43.50, sheet bars and small billets \$47, slabs \$46 and rods \$57.

Pig iron prices are likewise firmly maintained as follows: Bessemer, \$32.20; basic, \$30; No. 2 foundry, \$31; malleable, \$31.50; forge, \$30. These prices are, in general, f.o.b. furnace, and represent \$3 reduction from Government limits.

Producers experience no difficulty in maintaining prices, as there is no temptation, by way of business offered, to cut prices.



### Chemical Market

**COAL TAR PRODUCTS:**—The position of coal-tar products is somewhat easier and reports from most directions would indicate trading on the whole is in reasonably good volume, but individual sales are of a minor character and buying is still along conservative lines. Buyers are seemingly holding back, anticipating a further decline in prices before bringing their full requirements to the market. Producers are in full accord with this situation, but maintain that their present prices reflect sufficiently well, in view of the costs in production, claiming that labor and raw materials are still maintained at high levels. Among the crudes benzol shows the same steady trend, with trading in reasonably good proportions. Phenol remains in an unsettled condition, while toluol holds close to the levels heard for some time past.

**Benzol:**—Producers of this commodity have not altered their recent quotations and the situation remains in strong hands with only occasional lots appearing in the resale market.

**Phenol:**—Trading in this commodity has developed to no unusual proportions, with quantities of the product reaching the resale market at prices as low as 11c. and sales are reported to be passing at this figure.

**Toluol:**—Consuming demand continues along quiet lines, with offerings through second hands being made at prices 2c. below manufacturers', who have made no changes in their recent quotations.

**Dinitrochlorbenzol:**—Trading in the general market is in small lots and supplies seem to have accumulated but in no important quantities. Manufacturers have reduced their prices 5c. per pound.

**Alpha Naphthylamine:**—Price changes to extent of 2c. per pound have been made, but this cut has seemingly had no effect in stimulating business and available supplies are more than sufficient for the current call.

**Orthotoluidine:**—The market for this commodity has been without special feature for some time back and the continued indifference on the part of consumers is still in evidence. Stocks are in considerable quantities, but prices have not changed since the recent decline.

**Dinitrophenol:**—There has been a little increase in the general demand for this product since the reduction in the selling schedules last week, but at the present trading is confined to small lots.

**Dinitrotoluol:**—The lack of consumption requirements has brought about an easier situation so far as stocks are concerned, but prices remain quotably unchanged.

**Metanitraniline:**—Supplies of this material which are reaching the market are none too liberal, but on the other hand the demand is in proportion, therefore the situation is met without difficulty and prices are firm.

**Mixed Toluidine:**—A satisfactory movement is generally reported for the product, but individual sales are in small lots and indicate buying is carried along on conservative lines. Prices have not been subject to any material change since the recent decline.

**Beta Naphthylamine:**—While there is no pronounced activity in this market a fairly steady business is evident, with stocks fully in proportion to the current call and prices are firmly maintained.

**Diphenylamine:**—The product presents a quiet appearance, with no important interest noted in any single direction. Despite this quietness prices remain at the same firm levels.

**Paraphenylenediamine:**—Supplies of this material are in fairly good quantities and trading is along conservative lines, but of sufficient volume to take the slack off the market. Dealers who are offering have not altered their recent prices for the various grades.

**HEAVY CHEMICALS:**—There was not much snap in business during the interval, although there was a fairly good demand evident for some of the items for export purposes, but dealers are looking forward to a larger volume of trading in this direction. Second hands seem to be in full

control of the market, which is general during this period of the year, in view of the carry-over of stocks, but manufacturers seem to be more inclined to meet this situation, making an effort to bring about a more equitable condition, although dealers seem to be so overstocked with many of the heavy chemicals that price cutting is active and the entire situation favors the buyer. For instance, bichromate of soda sold in the resale market at 13c. on spot, caustic soda and soda ash sales were consummated at some low levels. Price conditions on the spot were such that pressure on the part of sellers, second hands, developed to such an extent that many of the items were subject to a decline, but this apparently had no effect on stimulating additional business.

**Soda Ash:**—During the latter part of the week single bag ash was subject to a more active inquiry, but actual transactions were of moderate proportions, with sales being consummated at \$1.40 per hundred pounds from the warehouse. Odd lots of barrel material were sold at \$1.65 ex-warehouse, with the general quotation ranging from \$1.75 to \$1.85 per hundred pounds. Double bag ash in the Middle West was subject to virtually no call, therefore exporting of this product has developed to a nominal position.

**Caustic Soda:**—Odd lot trading seems to have been the feature of this market and the sales noted during the week were for export material, which was sold at prices ranging from \$3.20 to \$3.25 per hundred pounds f.a.s. Offerings from the warehouse were being liberally made at \$3.05 per hundred pounds ex-store, while some scattered lots of material were offered at \$3.10 to \$3.20 f.a.s. Ground caustic was subject to no unusual call, with offerings by first hands being made at \$4.50 per hundred pounds ex-store, while resale material was available at \$4.15.

**Bleaching Powder:**—Comparatively little is heard from buyers of this commodity and the sales noted would indicate purchasing is along conservative lines. However, a fair movement is experienced for export purposes, although demand in this direction is not of such proportions that any difficulty is experienced in meeting the situation. Manufacturers are quoting large domestic drums from works at 2c. per pound, while this price is shaded by second hands for spot goods. Export drums at the works are offered by producers at 2½c. per pound, with material in the resale market being available at 3c. f.a.s.

**Yellow Prussiate of Soda:**—Offerings of the material have reached the resale market at prices as low as 26c., with some sales passing at this figure, while the general market quotation ranges from 27c. to 28c.

**Permanganate of Potash:**—The continued lack of demand has brought about a steady decline in prices for this product, with virtually no interest in the technical variety, and sales for the U. S. P. grade were noted at 95c. per pound. Buyers are seemingly interested in only such lots as are needed for immediate use. Resale lots were offered at prices ranging from \$1.00 to \$1.05 per pound for the U. S. P.

**Bichromate of Soda:**—Quiet trading in addition to keener competition among holders who show some anxiety to sell has brought about prices as low as 13c. with actual sales noted at this figure. There were offerings throughout the market at prices ranging from 13½c. to 15c. ex-store.

**Chlorate of Potash:**—Export trading in this commodity has been sufficiently active to maintain a rather firm market, with no disposition on the part of holders to shade the price of 40c. f.a.s., although there were offerings of the Japanese product at 33c. per pound ex-warehouse.

**Cyanide of Soda:**—Consuming requirements seem to be sufficient to keep the position of this item firm and available supplies are none too liberal. However, there has apparently been no difficulty experienced in filling orders. Prices are steady at 30c. to 31c. per pound.

**Hyposulphite of Soda:**—A rather firm situation continues for this item, although the demand is not persistent, but on the other hand stocks are none too liberal in supply. Sellers quote on the former basis of \$3.60 for the pea crystals and \$3.25 for the regular crystals, per hundred pounds.

## General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET FEB. 8, 1919

Acetic anhydride.....	lb.	.90	1.00
Acetone.....	lb.	.15	.16
Acid, acetic, 28 per cent.....	cwt.	3.25	3.50
Acetic, 56 per cent.....	cwt.	6.50	6.75
Acetic, glacial, 99 1/2 per cent, carboys.....	cwt.	14.00	14.50
Boric, crystals.....	lb.	.13	.12
Citric, crystals.....	lb.	1.25	1.27
Hydrochloric, (22%).....	cwt.	2.50	3.00
Hydrofluoric, 30 per cent, in barrels.....	lb.	.08	.08 1/2
Lactic, 44 per cent.....	lb.	.14	.15
Lactic, 22 per cent.....	lb.	.06	.07
Molybdenum, C. P.....	lb.	6.90	7.40
Nitric, 36 deg.....	lb.	.07	.08
Nitric, 42 deg.....	lb.	.08 1/2	.10
Oxalic, crystals.....	lb.	.36	.38
Phosphoric, 47-50 per cent paste.....	lb.	.07 1/2	.10
Phosphoric, ref. 50 per cent.....	lb.	.35	.40
Picric.....	lb.	.75	.85
Pyrogallol, resublimed.....	lb.	3.25	3.50
Sulphuric, 60 deg works.....	ton	14.00	16.00
Sulphuric, 66 deg works.....	ton	26.00	21.00
Sulphuric, oleum (Fuming), tank cars.....	ton	60.00	65.00
Tannic, U. S. P., bulk.....	lb.	1.40	1.50
Tartaric, crystals.....	lb.	.85	.87
Tungstic, per lb. of W.....	lb.	1.70	1.75
Alcohol, sugar cane, 188 proof.....	gal.	4.85	5.00
Alcohol, wood, 95 per cent.....	gal.	1.28	1.30
Alcohol, denatured, 180 proof.....	gal.	.52	.54
Alum, ammonia lump.....	lb.	.05 1/2	.06
Alum, chrome ammonium.....	lb.	.17 1/2	.18
Alum, chrome potassium.....	lb.	.20	.22
Alum, chrome sodium.....	lb.	.12 1/2	.13
Alum, potash lump.....	lb.	.09 1/2	.10
Aluminium sulphate, technical.....	lb.	.02 1/2	.02 1/2
Aluminium sulphate, iron free.....	lb.	.03 1/2	.03 1/2
Ammonia aqua, 26 deg., carboys.....	lb.	.07	.08 1/2
Ammonia, anhydrous.....	lb.	.40	.45
Ammonium carbonate.....	lb.	.13	.14
Ammonium nitrate.....	lb.	.16	.17
Ammonium sulphate domestic.....	lb.	.06	.07
Amyl acetate.....	gal.	3.75	4.25
Arsenic, white.....	lb.	.10	.11
Arsenic, red.....	lb.	.65	.70
Barium carbonate, 99 per cent.....	ton	80.00	90.00
Barium carbonate, 97-98 per cent.....	ton	65.00	67.00
Barium chloride.....	ton	65.00	75.00
Barium sulphate (Blanc Fixe, Dry).....	lb.	.04 1/2	.05
Barium nitrate.....	lb.	.10	.11
Barium peroxide, basis 70 per cent.....	lb.	.30	.32
Bleaching powder, 35 per cent chlorine.....	lb.	.02	.03 1/2
Borax, crystals, sacks.....	ton	.08 1/2	.08 1/2
Brimstone, crude.....	ton	65.00	70.00
Bromine, technical.....	lb.	.65	.70
Calcium, acetate, crude.....	lb.	.04	.05
Calcium, carbide.....	lb.	.10 1/2	.11 1/2
Calcium chloride, 7-75 per cent, fused, lump.....	ton	22.00	24.00
Calcium peroxide.....	lb.	1.50	1.70
Calcium phosphate.....	lb.	.22	.23
Calcium sulphate, 98-99 per cent.....	lb.	.09	.09 1/2
Carbon bisulphide.....	lb.	.08	.09
Carbon tetrachloride, drums.....	lb.	.15	.16
Carbonyl chloride (phosgene).....	lb.	.75	1.00
Caustic potash, 88-92 per cent.....	lb.	.57	.62
Caustic soda, 76 per cent.....	100 lb.	3.05	3.15
Chlorine, liquid.....	lb.	.10	.12
Cobalt oxide.....	lb.	1.60	1.65
Copperas.....	lb.	.01 1/2	.02 1/2
Copper carbonate.....	lb.	.30	.31
Copper cyanide.....	lb.	.75	.78
Copper sulphate, 99 per cent, large crystals.....	lb.	.08 1/2	.08 1/2
Cream of tartar, crystals.....	lb.	.60 1/2	.63
Epsom salt, bags, U. S. P.....	100 lb.	2.75	2.85
Formaldehyde, 40 per cent.....	lb.	.22 1/2	.23
Glauber's salt.....	lb.	.02	.02 1/2
Glycerine, bulk, C. P.....	lb.	.20	.21
Iodine, resublimed.....	lb.	4.25	4.30
Iron oxide.....	lb.	.06	.08
Lead acetate, white crystal.....	lb.	.17	.17 1/2
Lead arsenate (Paste).....	lb.	.15	.18
Lead nitrate, C. P.....	lb.	.85	.86
Litharge, American.....	lb.	.11	.12
Lithium, carbonate.....	lb.	1.50	2.05
Magnesium carbonate, technical.....	lb.	.16	.17
Nickel salt, single.....	lb.	.14	.15
Nickel salt, double.....	lb.	.12	.13
Phosgene (see Carbonyl chloride).....	lb.	.75	1.00
Phosphorus, red.....	lb.	.90	.95
Phosphorus, yellow.....	lb.	.38	.40
Potassium bichromate.....	lb.	1.25	1.26
Potassium bromide granular.....	lb.	.38	.40
Potassium carbonate calcined, 85-90 per cent.....	lb.	.38	.40
Potassium chlorate, crystals.....	lb.	.60	.70
Potassium cyanide, 98-99 per cent.....	lb.	3.75	3.80
Potassium iodide.....	ton	300.00	350.00
Potassium muriate, 80-85 p. c. basis of 80 p. c.....	lb.	.27	.31
Potassium nitrate.....	lb.	1.05	1.10
Potassium permanganate, U. S. P.....	lb.	1.75	1.85
Potassium prussiate, red.....	lb.	.62	.65
Potassium prussiate, yellow.....	lb.	.62	.65
Potassium sulphate, 90-95 p. c. basis 90 p. c.....	ton	Nominal	Nominal
Rochelle salt.....	lb.	.46 1/2	.48
Sal ammoniac, gray gran.....	lb.	.16	.18
Sal ammoniac, white gran.....	lb.	.14	.16
Sal soda.....	100 lb.	1.75	2.00
Salt cake.....	ton	18.00	20.00
Silver cyanide, based on market price of silver.....	oz.	.63 1/2	.64
Silver nitrate.....	lb.	1.40	1.60
Soda ash, 58 per cent, light, flat (bags).....	100 lb.	3.35	3.50
Soda ash, 58 per cent, dense, flat.....	100 lb.	.12	.13
Sodium acetate.....	lb.	.02 1/2	.02 1/2
Sodium bicarbonate, domestic.....	lb.	.14 1/2	.15 1/2
Sodium bicarbonate, English.....	lb.	.12	.14
Sodium bichromate.....	lb.	.18 1/2	.19
Sodium bisulphite, powd.....	lb.	.30	.35
Sodium chlorate.....	lb.	.16	.17
Sodium fluoride, commercial.....	lb.	.16	.17

Sodium hyposulphite.....	100 lb.	3.25	3.60
Sodium molybdate, per lb. of Mo.....	lb.	2.50	—
Sodium nitrate, 95 per cent.....	100 lb.	4.42	4.55
Sodium nitrite.....	lb.	.14	.16
Sodium peroxide.....	lb.	.35	.45
Sodium phosphate.....	lb.	.04	.04 1/2
Sodium prussiate, yellow.....	lb.	.28	.30
Sodium silicate, liquid (60 deg.).....	lb.	.05	.06
Sodium sulphide, 30 per cent, crystals.....	lb.	.02	.03
Sodium sulphide, 60 per cent, fused.....	lb.	.04 1/2	.05
Sodium sulphite.....	lb.	.05 1/2	.06
Strontium nitrate.....	lb.	.25	.30
Sulphur chloride, drums.....	lb.	.07 1/2	.09
Sulphur dioxide, liquid, in cylinders.....	lb.	.15	.40
Sulphur, flowers, sublimed.....	100 lb.	4.35	4.50
Sulphur, roll.....	100 lb.	3.70	3.85
Sulphur, crude.....	ton	35.00	—
Tin bichloride, 50 deg.....	lb.	.28	.29
Tin oxide.....	lb.	.75	.76
Zinc carbonate.....	lb.	.18	.20
Zinc chloride.....	lb.	.15	.15 1/2
Zinc cyanide.....	lb.	Nominal	Nominal
Zinc dust, 350 mesh.....	lb.	.13 1/2	.14
Zinc oxide, American process, works.....	lb.	.10	.12
Zinc sulphate.....	lb.	.04 1/2	.06 1/2

## Coal Tar Products (Crude)

Benzol, pure, water white.....	gal.	.22	.27
Benzol, 90 per cent.....	gal.	.25	—
Toluol, in tank cars.....	gal.	.25	—
Toluol, in drums.....	gal.	.30	.35
Xylol, pure, water white.....	gal.	.45	.55
Solvent naphtha, water white.....	gal.	.20	.25
Solvent naphtha, crude, heavy.....	gal.	.15	.17
Cresote oil, 25 per cent.....	gal.	.45	.55
Dip oil, 20 per cent.....	gal.	.35	.40
Pitch, various grades.....	ton	8.00	20.00
Carbolic acid, crude, 95-97 per cent.....	lb.	Nominal	Nominal
Carbolic acid, crude, 50 per cent.....	lb.	Nominal	Nominal
Carbolic acid, crude, 25 per cent.....	lb.	Nominal	Nominal
Cresol, U. S. P.....	lb.	.18	.20

## Intermediates, Etc.

Alpha naphthol, crude.....	lb.	1.00	1.10
Alpha naphthol, refined.....	lb.	1.50	1.60
Alpha naphthylamine.....	lb.	.48	.50
Aniline oil, drums extra.....	lb.	.25	.27
Aniline salts.....	lb.	.36	.40
Anthracene, 80 per cent.....	lb.	.50	.55
Benzaldehyde (f.f.s.).....	lb.	4.25	4.50
Benidine, base.....	lb.	1.45	1.60
Benidine, sulphate.....	lb.	1.15	1.25
Benoic acid, U. S. P.....	lb.	1.80	1.90
Benzoate of soda, U. S. P.....	lb.	1.65	1.70
Benyl chloride.....	lb.	1.00	—
Beta naphthol benzoate.....	lb.	5.50	6.00
Beta naphthol, sublimed.....	lb.	.75	.85
Beta naphthylamine, sublimed.....	lb.	2.60	2.65
Dichlorobenzol.....	lb.	.15	.20
Diethylaniline.....	lb.	3.25	4.00
Dinitrobenzol.....	lb.	.36	.38
Dinitrochlorobenzol.....	lb.	.30	.35
Dinitronaphthalene.....	lb.	.55	.60
Dinitrotoluol.....	lb.	.40	.50
Dinitrophenol.....	lb.	.39	.45
Dimethylaniline.....	lb.	.57	.65
Diphenylamine.....	lb.	.75	.85
H-acid.....	lb.	2.35	2.75
Metaphenylenediamine.....	lb.	1.55	1.75
Monochlorobenzol.....	lb.	.16	.19
Naphthalene, flake.....	lb.	.08	.09
Naphthalene, balls.....	lb.	1.1 1/2	1.2 1/2
Naphthionic acid, crude.....	lb.	1.20	1.30
Naphthylamine-di-sulphonic acid.....	lb.	1.00	1.10
Nitro naphthalene.....	lb.	.45	.50
Nitro toluol.....	lb.	.55	.60
Ortho-amidophenol.....	lb.	6.00	7.00
Ortho-dichlor-benzol.....	lb.	.15	.20
Ortho-toluidine.....	lb.	.50	.90
Ortho-nitro-toluol.....	lb.	.75	.85
Para-amidophenol, base.....	lb.	3.25	3.65
Para-amidophenol, H. C. L.....	lb.	3.75	4.25
Para-dichlor-benzol.....	lb.	.15	.20
Paranitraniline.....	lb.	1.40	1.60
Para-nitro-toluol.....	lb.	1.50	1.60
Paraphenylenediamine.....	lb.	3.25	3.50
Para-toluidine.....	lb.	2.00	2.25
Phthalic acid anhydride.....	lb.	3.25	3.50
Phenol, U. S. P.....	lb.	Nominal	Nominal
Resorcin, technical.....	lb.	4.50	5.00
Resorcin, pure.....	lb.	7.00	8.00
Salicylic acid, U. S. P.....	lb.	.60	—
Salol.....	lb.	1.50	2.00
Sulphanilic acid, crude.....	lb.	.25	.31
Toluidine.....	lb.	2.45	—
Toluidine-mixture.....	lb.	.80	1.00

## Petroleum Oils

Crude (at the Wells)

Pennsylvania.....	bbl.	4.00	—
Corning, Ohio.....	bbl.	2.85	—
Somerset, Ky.....	bbl.	2.60	—
Wooster, Ohio.....	bbl.	2.58	—
Indiana.....	bbl.	2.28	—
Illinois.....	bbl.	2.25	—
Oklahoma and Kansas.....	bbl.	2.25	—
Cadizo, La, light.....	bbl.	2.10	2.25
Corianna, Tex., light.....	bbl.	2.25	—
California.....	bbl.	1.24	1.57
Gulf Coast.....	bbl.	1.25	—
Mexican.....	bbl.	1.90	—
Fuel Oil			
New York.....	gal.	.15	—
Philadelphia.....	gal.	.10 1/2	—
Baltimore.....	gal.	.07 1/2	.15
Pittsburgh.....	gal.	.07 1/2	.10 1/2
Texas.....	bbl.	1.85	2.35
Los Angeles.....	bbl.	1.65	—



## Gasoline (Wholesale)

New York, motor	gal.	.24	—	—
Gas machine	gal.	.41	—	—
72-76 degrees	gal.	.33	—	.39
70-72 degrees	gal.	.32	—	.37
67-70 degrees	gal.	.30	—	.36
Pittsburgh, motor	gal.	.25	—	—
Chicago, motor	gal.	.21	—	—
Oklahoma, motor	gal.	.23	—	—
San Francisco, motor	gal.	.20	—	—

## Paraffine Waxes

Crude, 103 to 105 deg. m.pt.	lb.	.08	—	.09
Crude, 118 to 120 deg. m.pt.	lb.	.09	—	.10
Crude, 124 to 126 deg. m.pt.	lb.	.10	—	—
Refined, 120 deg. m.pt.	lb.	.13	—	—
Refined, 128 deg. m.pt.	lb.	.14	—	—
Refined, 135 deg. m.pt.	lb.	.16	—	.16
Osokerite, brown	lb.	.75	—	.80
Osokerite, green	lb.	.85	—	.90

## Lubricants

Black, reduced, 29 gravity, 25-30 cold test	gal.	.24	—	.25
Cylinder, light	gal.	.42	—	.44
Cylinder, dark	gal.	.39	—	.43
Paraffine, high viscosity	gal.	.40	—	.41
Paraffine, 0.903 sp. gr.	gal.	.36	—	.38
Paraffine, 0.885 sp. gr.	gal.	.26	—	.28

## Flotation Oils

(Prices at New York unless otherwise stated)

Pine oil, crude, f. o. b. Florida	gal.	.44	—	—
Pine oil, steam-distilled, sp. gr. 0.925-0.940	gal.	.58	—	.60
Pine oil, destructively distilled	gal.	.58	—	.60
Pine-tar oil, sp. gr. 1.02-1.035	gal.	.35	—	—
Pine-tar oil, double refined, sp. gr. 0.965-0.990	gal.	.42	—	—
Pine-tar oil, ref., light, sp. gr. 0.950, tank cars, f.o.b. works	gal.	.37	—	—
Pine-tar oil, ref., heavy, sp. gr. 1.025, tank cars, f.o.b. works	gal.	.28	—	—
Pine-tar oil, ref., thin, sp. gr. 1.060-1.080	gal.	.32	—	—
Turpentine, crude, sp. gr. 0.870-0.900	gal.	.45	—	—
Hardwood oil, f.o.b. Michigan, sp. gr. 0.960-0.990	gal.	.23	—	—
Hardwood oil, f.o.b. Michigan, sp. gr. 1.06-1.08	gal.	.23	—	—
Wood creosote, ref., f.o.b. Florida	gal.	.31	—	—

## Naval Stores

Rosin A-E barrel	280 lb.	13.60	—	13.75
Rosin F-I	280 lb.	13.75	—	14.10
Rosin K-N	280 lb.	16.25	—	16.85
Rosin WG-W	280 lb.	17.00	—	17.25
Spirits of turpentine	gal.	.72	—	.75
Wood turpentine, steam distilled	gal.	.64	—	.65
Wood turpentine, destructively distilled	gal.	.63	—	.65
Pitch	bbl. 200 lb.	8.00	—	—
Tar, kiln dried	280 lb.	13.00	—	13.50
Retort tar	280 lb.	14.00	—	14.50
Rosin oil, first run	gal.	.77	—	—
Second run	gal.	.80	—	—
Third run	gal.	.85	—	—
Fourth run	gal.	.95	—	—

## Vegetable Oils

Castor oil	lb.	.25	—	.26
China wood oil	lb.	.23	—	.24
Cocconut oil	lb.	.16	—	.21
Corn oil	lb.	.14	—	—
Cottonseed oil, crude	lb.	.17	—	.22
Lined oil, raw, cars	gal.	1.45	—	1.48
Palm	lb.	.18	—	.21
Peanut oil, crude	lb.	.17	—	.21
Soya bean oil, Manchuria	lb.	.14	—	.15

## Glues

Extra white	lb.	.31	—	.35
Cabinet	lb.	.25	—	.26
Brown foot stock	lb.	.15	—	.19
Fish glue, 50-gal. barrels	gal.	1.00	—	1.50

## Miscellaneous Materials

Barytes, floated, white, domestic	ton	33.00	—	36.00
Beeswax, white, pure	lb.	.63	—	.65
Beeswax, unbleached	lb.	.43	—	.48
Blanc fixe	lb.	.05	—	—
Casein	lb.	.17	—	.30
Chalk, light, precipitated, English	lb.	.04	—	.06
China clay, imported, lump	ton	20.00	—	40.00
China clay, domestic, lump	ton	15.00	—	22.50
Feldspar	ton	8.00	—	12.00
Fluor spar, gravel, f. o. b. mines	ton	28.00	—	40.00
Fluor spar, washed, powdered	ton	90.00	—	—
Fuller's earth, powdered	100 lb.	1.50	—	2.00
Graphite	lb.	.08	—	.12
Ceylon	lb.	.09	—	.22
Madagascar	lb.	.10	—	.15
Mexican	ton	35.00	—	75.00
Japan wax	lb.	.18	—	.19
Orange shellac	lb.	.72	—	.80
Pumice stone	lb.	.04	—	.08
Soapstone	ton	15.00	—	25.00
Stearic acid	lb.	.17	—	.19
Talc, American, white	ton	20.00	—	40.00

## Refractories, Etc.

(F.O.B. Works)

Chrome brick	net ton	100.00	—	120.00
Chrome cement	net ton	75.00	—	—
Clay brick, first quality fireclay	per 1000	40.00	—	50.00
Clay brick, second quality	per 1000	35.00	—	40.00
Magnesite, raw	ton	30.00	—	35.00
Magnesite, calcined, powdered	ton	50.00	—	65.00
Magnesite, dead burned	net ton	38.00	—	40.00
Magnesia brick, 9x4x2	net ton	110.00	—	125.00
Silica brick	per 1000	45.00	—	55.00

## Ferroalloys

Ferrocobaltitium, 15-18 per cent, carloads, f. o. b. Niagara Falls, N. Y.	ton	200.00	—	250.00
Ferrocobaltium	lb.	15.00	—	30.00
Ferrocobaltium, per lb. of Cr.	lb.	.30	—	.40
Ferromanganese, domestic, 70 per cent basis	ton	150.00	—	200.00
Ferromanganese, English	ton	—	—	—
Spiegel Eisen (16-18%)	ton	60.00	—	—
Ferromolybdenum, per lb. of Mo.	lb.	3.50	—	4.50
Ferrosilicon, 75 per cent, f. o. b. N. Y.	ton	—	—	—
Ferrosilicon, 50 per cent, contract	ton	125.00	—	—
Ferrotungsten, 75-85 per cent, f.o.b. Pittsburgh	lb.	7.50	—	—
Ferroumadium, f.o.b. works, per lb. of U	lb.	—	—	—
Ferroumadium, f.o.b. works	lb.	—	—	—

## Ores and Semi-finished Products

Chrome ore, 45 per cent minimum, f.o.b. Cal. per unit	ton	1.50	—	1.55
Coke	ton	6.00	—	7.00
Petroleum Coke	ton	16.00	—	—
Manganese ore, 48 per cent and over, per unit	ton	1.20	—	—
Manganese ore, chemical	ton	80.00	—	100.00
Molybdenite, per lb. of MoS <sub>2</sub>	lb.	1.25	—	1.50
Tungsten, Scheelite, per unit of WO <sub>3</sub>	ton	17.00	—	24.00
Tungsten, Wolframite, per unit of WO <sub>3</sub>	ton	15.00	—	21.00
Uranium oxide, 96%	lb.	3.25	—	3.60
Vanadium pentoxide, 99%	lb.	10.50	—	—
Pyrites, foreign	unit	.17	—	—
Pyrites, domestic	unit	.28	—	.30

## Plant Supplies

## BUILDING MATERIALS

Common clay bricks	M	14.00	—	15.00
Face brick	M	37.00	—	46.00
Hollow tile, 4x12x12	M	60.00	—	—
Hollow tile, 12x12x12	M	170.00	—	—
Lime	M	16.50	—	—
Portland cement	bbl.	2.59	—	—
Single glass (82-lb.), 10x26-16x24	—	21.00	—	27.00
Double glass (164 lb.), 10x26-16x24	—	31.00	—	39.00
Yellow pine lumber	M	39.00	—	45.00
Cypress	M	70.00	—	—
Tarred felt (14-lb. sq.)	ton	61.00	—	—
Roofing pitch	ton	27.00	—	—
Asphalt coated roofing (35-55-lb. sq.)	sq.	1.60	—	2.45
Slate surfaced asphalt shingles	sq.	5.25	—	5.50
Corrugated galvanized iron	ton	109.00	—	127.00
Putty	100 lb.	6.25	—	—
Red oxide (Ppte. Copperas)	100 lb.	15.00	—	20.00
Native red oxide	100 lb.	3.25	—	8.00
Red metallic paint	100 lb.	1.20	—	1.50
White lead in oil	100 lb.	15.00	—	16.00
White lead (dry)	100 lb.	11.00	—	13.00
Red lead in oil	100 lb.	12.28	—	14.50
Red lead (dry)	100 lb.	14.50	—	—
Zinc oxide (dry)	100 lb.	13.00	—	14.50
Zinc oxide—loaded	100 lb.	9.00	—	10.00
Yellow ochre	100 lb.	1.50	—	10.00
Ultra marine blue	100 lb.	14.00	—	50.00
Prussian blue	100 lb.	135.00	—	150.00
Chrome green	100 lb.	40.00	—	70.00
Paris green	100 lb.	43.00	—	49.00
Mineral black	100 lb.	1.75	—	2.25
Powdered bone black	100 lb.	5.50	—	12.00
Lampblack	100 lb.	15.00	—	45.00
Gas carbon	100 lb.	16.00	—	25.00
Mexican petroleum pitch	100 lb.	1.00	—	2.00
Gilaonite	100 lb.	2.00	—	2.50
Coal tar pitch	100 lb.	.60	—	1.25

## STRUCTURAL IRON

Blue annealed sheet iron	ton	77.00	—	82.00
Black sheet iron	ton	90.00	—	96.00
Galvanized iron	ton	101.00	—	131.00
Tern plate, 8-lb. coating	ton	145.00	—	148.00
Tern plate, 15-lb. coating	ton	175.00	—	—
Tern plate, 25-lb. coating	ton	200.00	—	—
Tern plate, 40-lb. coating	ton	230.00	—	—
Tin plate, prime	ton	147.00	—	155.00
Tank plates	ton	60.00	—	65.00
Beams, channels, angles, T's, Z's	ton	56.00	—	60.00
Rivets	ton	88.00	—	92.00
Steel pipe, 1 to 3-inch	ton	60.00	—	70.00
Bar iron and steel	ton	150.00	—	—
Chain (1 inch proof coil)	ton	70.00	—	80.00
Nails, bolts, nuts, washers	ton	300.00	—	500.00
Tool steel, special alloys	ton	32.00	—	35.20
Bessemer pig iron	ton	43.50	—	47.50
Bessemer steel	ton	37.90	—	—
No. 2 foundry	ton	47.50	—	—
Steel billets (4 x 4)	ton	—	—	—

## POWER HOUSE SUPPLIES

Steam packing, rubber duck	lb.	.99	—	1.10
Asbestos, high pressure	lb.	1.76	—	—
Asbestos, wired	lb.	1.30	—	—
Asbestos, graphited braid	lb.	1.21	—	—
Asbestos, wick	lb.	.66	—	—
Rubber, sheet	lb.	.07	—	—
Cup grease	lb.	.07	—	—
Transmission grease	lb.	.04	—	—
Axle grease	lb.	.04	—	—
Gear grease	lb.	.04	—	—
Cotton waste	lb.	.08	—	.11
Hose, underwriters, 2 1/2 in.	ft.	.75	—	—
Hose, air, 1 in.	ft.	.50	—	.60

# INDUSTRIAL

Financial, Construction and Manufacturers' News

## Construction and Operation

### Arizona

CLIFTON.—J. Cristy, lessee of the Lazinsky group of mines between Clifton and Metcalf, will build a 250-ton mill at the copper mines here.

GLOBE.—The Gila Monster Mining Co. will build a 50-ton cyanide mill for its Richmond Basin property, seven miles north of here. W. H. Seamon, superintendent.

OATMAN.—The Mossback Mining Co., Kingman, will build a milling plant here this year. Estimated cost, \$400,000.

### California

OXNARD.—The city trustees plan an election to vote on \$140,000 bond issue for the construction of a gas plant.

TURLOCK.—The city trustees contemplate the construction of a new sewage disposal plant. Plans for same have been submitted to the Board of Health for approval.

### Colorado

MONTROSE.—J. N. McBride, representing a syndicate of Colorado and Michigan mining men, has acquired an option on the Cash In Mine, Montrose County, and will build a flotation mill.

### Connecticut

HARTFORD.—The city will build a filtration plant. Estimated cost, \$400,000. C. Mills Soville, superintendent of waterworks.

### Florida

FORT LAUDERDALE.—The city will install softening and filtration plants in connection with the improvements it plans to the waterworks. Total estimated cost, \$30,000. H. C. Davis, city engineer.

### Idaho

SALMON.—The Harmony Mines Co., 602 Hearst Bldg., Chicago, Ill., will install a concentration plant and mill at their property here. Estimated cost, \$45,000. A. W. Nieman, manager.

### Illinois

GILLESPIE.—The village plans to build a water system, to include a filter plant, reservoir and pumping station. Miller, Holbrook & Warren, 517 Milliken Bldg., Decatur, engineer.

SPRINGFIELD.—The city will build a sewage disposal plant. Wade Seeley, City Hall, engineer.

WOODRIVER.—The Standard Oil Co. of Indiana, 910 South Michigan Ave., Chicago, will build an addition to its refinery here. C. B. Manbeck, Woodriver, local manager.

### Indiana

EAST CHICAGO.—Bids will be received until February 25 by C. L. Kirk, vice-president of the East Chicago & Indiana Harbor Water Co., 113 Monument Circle, Indianapolis, for the construction of a water purification plant, consisting of chemical house, filter house, boiler house and pumping plant addition, sedimentation basins and filtered water reservoir.

### Louisiana

BATON ROUGE.—The Illinois Central R.R., Central Station, Chicago, Ill., has awarded the contract for the construction of a one story, 25 x 40 ft. filtration plant, having a capacity of 25,000 gallons per hour, to the Graver Tank Works, 4809 Todd Ave., Chicago, Ill. Estimated cost, \$18,000.

### Maryland

BALTIMORE.—The city will build a filtration plant. Estimated cost, \$25,000. J. W. Lee, city engineer.

### Massachusetts

ASHLAND.—The United States Color &

Chemical Co., 15 Custom House, Boston, will build a three story, 44 x 84 ft. research building here.

### Minnesota

MOUNTAIN IRON.—The Board of Education will install a filter and purification plant for swimming pool, in connection with the 3 story, 145 x 173 ft. school which it plans to build on Main St. Total estimated cost, \$200,000. H. C. Mitchell, secretary.

### Mississippi

PASCAGOULA.—The City Commissioners will receive bids until Mar. 11 for the construction of sanitary and storm drainage sewers to include a sewage disposal plant. Xavier A. Kramer, Magnolia, engineer.

### Missouri

ST. LOUIS.—The Floor Shine Paint & Varnish Co., 2744 Olive St., will build an addition to its factory. Estimated cost, \$30,000.

### Nebraska

OMAHA.—The Omaha Refining Co., Theatre Building, will build oil refinery consisting of two buildings, two stories, 24 x 80 ft. each, at East Omaha. Estimated cost, \$10,000. D. W. Lennox, 460 Brandeis Theatre Building, engineer.

### New Jersey

MILLTOWN.—The Elizabethtown Water Co., 68 Broad St., Elizabeth, will build a filter house and pumping station here. Estimated cost, \$150,000.

NEWARK.—The Department of Streets and Public Improvements has recommended that City Council issue \$250,000 bonds for the construction of a garbage disposal plant; plans include the construction of two small incinerators and a reduction plant.

PHILIPSBURG.—The city will build a sewage purification plant. Estimated cost, \$500,000. C. E. Tilton, city engineer.

### New York

BROOKLYN.—The State Hospital Commission, Capitol, Albany, will receive bids until Feb. 19, for building a sewage disposal plant at the Creedmoor Division of the Brooklyn State Hospital. Estimated cost, \$30,000. Noted Oct. 15.

BUFFALO.—The University of Buffalo, 24 High St., will build a chemical laboratory. About \$150,000 available for same.

NEW YORK.—The Commissioner of Water Supply, Gas & Electricity, Municipal Building, received bids Feb. 5 for furnishing and delivering liquid chlorine, from the Hooker Electro Chemical Co., 40 Wall St., \$7955; Arnold Hoffman Co., Inc., 55 Canal St., Providence, R. I., \$8295; Electro Bleaching Gas Co., 18 East 41st St., \$8395; furnishing and delivering chloride of lime, from Arnold Hoffman Co., Inc., 55 Canal St., Providence, R. I., \$1095; Knickerbocker Supply Co., 147 Church St., \$1437; H. Greenberg, 120 Broadway, \$1554. Noted Feb. 1.

ROCHESTER.—The city will build a sewage disposal plant, in the 23rd Ward near the Roma, Watertown & Ogdensburg R.R. bridge. Estimated cost, \$30,000.

POUGHKEEPSIE.—The State Hospital Commission, Capitol, Albany, will soon award the contract for improving and enlarging water system at the Hudson River State Hospital here involving the building of an intake crib in the Hudson River thence to filters, changing water main and reservoir. Estimated cost, \$40,000. L. F. Pilcher, state architect. Noted Feb. 15.

UTICA.—The State Hospital Commission, Capitol, Albany, will receive bids until March 4 for the construction of a two story, 44 x 60 ft. laboratory and mortuary at the State Hospital here. Estimated cost, \$50,000. Noted Jan. 15.

WATERTOWN.—Knowlton Bros., 139 Mill St., will build an addition to its paper mill. Estimated cost, \$50,000. C. Eaton, Sherman Building, engineer.

### North Carolina

WILMINGTON.—The city has awarded the contract for building four filter units, each having a daily capacity of 400,000 gallons, to the Pittsburgh Filter Co., Farmers Bank Building, Pittsburgh, Penn. Estimated cost, \$50,000.

### Ohio

OBERLIN.—The Board of Education is having plans prepared by F. C. Warner, architect, 767 Hippodrome Annex, Cleveland, for the construction of a two story, 75 x 180 ft. high school building, to include chemistry, botany and agricultural laboratories, etc. Total estimated cost, \$225,000.

### Oklahoma

BILLINGS.—The Greater Oklahoma Oil Corporation will build a refinery having a capacity of 2000 barrels, and is in the market for tanks, pumps and stills. G. B. Shirrett, president.

### Pennsylvania

ERIE.—The city will construct an intercepting sewerage system and a sewage disposal plant. Chester & Fleming, Union Bank Building, Pittsburgh, engineer.

TIDIOUTE.—The National Gasoline Co., recently organized with a capital of \$200,000, will build a large refinery here.

### Rhode Island

PROVIDENCE.—The Public Building Commission, City Hall, will install a chemical laboratory in the three story, 300 x 170 ft. high school building which it plans to construct on Pond St. Total estimated cost, \$500,000. Hoppin & Field, 32 Westminster St., architect.

### South Carolina

CHARLESTON.—The Eitwan Fertilizer Co. will rebuild its two story acid chambers on the Cooper River recently destroyed by fire. Estimated cost, \$125,000. F. Burledge, president.

### Texas

FORT WORTH.—The Panther City Oil & Refining Co. will build an oil refinery, having a daily capacity of 10,000 barrels. W. B. Townsend, Flatiron Building, president.

HOUSTON.—The Crown Oil Co. has awarded the contract for the construction of an oil refinery on the Houston Ship Channel, to the W. C. Hedrick Construction Co. Estimated cost, \$750,000. Noted Dec. 15.

### Virginia

MONEY POINT (Gilmerton P. O.).—The Hubbard Fertilizer Co., 802 Keyser Building, Baltimore, Md., has awarded the contract for the construction of a one and two story, 150 x 192 ft. fertilizer plant here, to W. J. Gregory, 501 Law Building. Estimated cost, \$50,000.

NEWPORT NEWS.—The Construction Division of the War Department, Washington, D. C., will build a sewage disposal plant and septic tank at Camp Alexander, here. Estimated cost, \$20,000.

### West Virginia

ELKINS.—The city will install a filtration system. Address A. M. Wardle, Sanitary Branch of the State Health Department, Charleston.

### Wisconsin

MENASHA.—The Lakeside Paper Co. will build an addition to its paper mill. Estimated cost, \$80,000.

RICE LAKE.—Stein, Hirsch & Co., 111 West Washington St., Chicago, Ill., will build an addition to its starch factory here. Estimated cost, \$200,000.

### British Columbia

KASLO.—The Gibson Mining Co. will build a concentrator plant. Estimated cost, \$25,000. C. D. Empfield, secretary-treasurer.

VANCOUVER.—The L'Air Liquide Societe, 1 Ernest St., Montreal, Que., has awarded the contract for the construction of a two story, 75 x 85 ft. factory, on 5th and Yukon Sts., to S. J. Newitt, 954 17th St. W. Estimated cost, \$25,000.

### Manitoba

WINNIPEG.—The Legislation Committee of the City Council will build a pulp and paper mill to be owned by the city. Estimated cost, \$3,000,000. F. O. Fowler, is interested.



## Ontario

**BRAMPTON.**—The town will install a filtration and sterilization plant. A. E. Davis, clerk.

## Quebec

**CAP DE LA MADELINE.**—The Riverside Lumber Co. will build a pulp mill here. Estimated cost, \$200,000. H. Bierman, manager of the Canadian-Belgo Pulp & Paper Co., Shawinigan Falls, is interested.

**GRAND MERE.**—The Laurentide Co., Ltd., McGibbon and 3rd Aves., will build a paper mill. Estimated cost, \$400,000. George Cahoon, president.

## Ontario

**OTTAWA.**—The Board of Control has applied to the City Council for authority to issue \$100,000 debentures for the construction of laboratories and nurses' quarters at the Royal Ottawa Sanatorium. A. F. MacCallum, City Hall, Ottawa, engineer.

## Coming Meetings and Events

**THE AMERICAN ELECTRO-PLATERS' SOCIETY, NEW YORK BRANCH,** will have its 10th annual banquet at the Broadway Central Hotel, Saturday, Feb. 22, at 7:30 p. m.

**THE AMERICAN INSTITUTE OF MINING ENGINEERS,** which includes the Institute of Metals Division, will meet at the New York Headquarters, 29 West 39th St., Feb. 17 to 20 inclusive.

**THE CANADIAN MINING INSTITUTE** will hold its twenty-first annual meeting on March 5 to 7, 1919.

**THE SOCIETY OF INDUSTRIAL ENGINEERS** plans a national conference at New York March 18-21 at the Hotel McAlpin, at which there will be a discussion of labor by both employers and labor leaders. Internal plant organization and also the elimination of fatigue will be other leading topics.

## Industrial Notes

**THE NEW JERSEY ZINC Co.** announces the removal of its general offices to 169 Front St., New York City.

**COLGATE & Co.,** 72 and 74 Grand Street, Jersey City, had an explosion on Feb. 4 in its laboratory which killed two men and injured seven, due to an electric spark igniting fumes of ether. Dr. George Pierce, a chemist, who was working with chemicals used in the manufacture of toilet preparations, was one of the victims.

**PASQUALE NIEKE & Co.,** Scoll D'Azeglio 7, Leghorn, Italy, handles the importation of machinery and tools and certain lines of chemicals, particularly nitrates, phosphates and sulphates. The company would like to establish connections with American manufacturers in these lines.

**THE PORTUGUESE IMPORT & EXPORT Co., LTD.,** Rua dos Douradores 83, Lisbon, Portugal, would like to correspond with American firms engaged in the sale of heavy chemicals with a view to becoming representatives.

**THE METAL & THERMIT CORP.,** New York City, announces the appointment of Mr. Arthur F. Braid as sales manager of the metal and alloy department. Mr. Braid started with this company seven years ago as a traveling salesman, but after a few years of service in that capacity he was appointed assistant superintendent of the Jersey City plant, in charge of the manufacture of carbon-free metals and alloys. When the United States entered the war, he assumed active charge of the metal sales at the New York office of the company.

**FACTORY PRODUCTS CORP.,** 2 Rector St., New York City, announces its organization for general export and import trade. It has acquired the business and goodwill of the Factory Products Export Corp. and the Manufacturers' Agents Co., Inc. The association of Bonbright & Co., Inc., will continue as financial agents for the consolidated companies. A new department for exportation of engineering supplies, machinery, hardware and building materials will be operated in association with the Engineers Corp., a subsidiary of the J. G. White Engineering Corp. of New York.

**THE LIBERTY NATIONAL BANK** of New York has created an industrial department for the purpose of offering advisory service on matters pertaining to manufacturing

and industrial problems. The new work will be directed by Mr. Donald D. Davis, who has had practical engineering, accounting and factory executive experience.

**WARREN, WEBSTER & Co.,** announce the opening of an office at 805 Sumpter Building, Dallas, Tex., with Mr. W. B. Irwin in charge as district representative.

**BUTLER & HAYES, INC.,** has opened an office at 220 Devonshire St., Boston, Mass., as mechanical and chemical consultant and experimental engineer. The testing laboratories are fully equipped for the study of industrial problems.

**THE AMERICAN BOSCH MAGNETO CORPORATION** is the official name of the former Bosch Magneto Co., which was recently sold by the Allen Property Custodian of the United States to the highest bidder. The entire holdings and organization, including the Bosch works at Springfield, Mass., have been taken over and the large output will now be devoted entirely to the requirements of American manufacturers and the public.

**THE EDISON STORAGE BATTERY Co.,** New York City, announces the removal of its New York sales office from 209 West 76th Street to 247-251 West 35th Street.

**THE ELECTRIC STEEL Co. OF INDIANA** has opened an office in the Penobscot Building, Detroit, Mich., with Mr. A. J. Kinnucan as district manager.

## Manufacturers' Catalogs

**THE HEINE SAFETY BOILER Co.,** St. Louis, Mo., has just received from the press the latest edition of "Boiler Logic," an 86-page treatise on steam boilers, with a supplement in color of a Heine boiler set over an underfeed stoker. This interesting catalog covers: I. Some fundamental considerations of boiler design; II. Practical baffling of water-tube boilers; III. Heine boilers for different fuels, firing and services; IV. Overloads; V. The boiler as a pressure vessel; and VI. Details of construction of the boilers.

**THE COKAL STOKES Co.,** Chicago, Ill., has issued two pamphlets on its stokers.

**THE STEERE ENGINEERING Co.,** Detroit, Michigan, calls attention to Bulletin No. 36, dealing with plant models. This 16-page booklet illustrates and describes practical methods employed in analyzing and determining the purchaser's requirements.

**THE LAKEWOOD ENGINEERING Co.,** Cleveland, Ohio: Bulletin No. 26 pictorially describes clamshell buckets, diggers and handlers, and gives general data as to type-size, load, water level, thickness of shells, weight, diameter of sheaves, cable size recommended, amount of cable overhauled, lifting speed per minute and horse power required together with descriptions of the different types.

**THE QUIGLEY FURNACE SPECIALTIES Co.,** New York City, calls attention to Bulletin No. 10 which treats of the air transport system for transporting and burning powdered fuel.

## New Publications

**THE JOURNAL OF THE AMERICAN STEEL TREATERS SOCIETY OF CHICAGO** has appeared and promises to contain valuable information, particularly for steel metallurgists. Mr. A. F. MacFarland, metallurgist, U. S. Ball Bearing Mfg. Co., Chicago, is chairman of the publication committee. The Journal will appear each month and will represent the activities of the American Steel Treating Society of Chicago. Mr. T. E. Baker, production engineer, Miehle Printing Press & Manufacturing Co. of Chicago, is president, and Mr. A. G. Henry, metallurgist, Illinois Tool Works, Chicago, is secretary-treasurer.

**THE MANUFACTURER'S WAGE PROBLEM.** By Herbert F. Perkins of the International Harvester Co. This pamphlet is published by the Union League Club of Chicago and can be purchased from them at 5c. per copy.

**NEW U. S. GEOLOGICAL SURVEY PUBLICATIONS:** I: A. The Economic Limits to Domestic Independence in Minerals. By George Otis Smith. (Mineral Resources of the U. S., 1917, Part I), published Dec. 28, 1918; I: B. International Control of Minerals. By C. K. Leith. (Mineral Resources of the U. S., 1917, Part I), published Dec. 31, 1918; I: C. Magnesium in 1917. By Ralph W. Stone. (Mineral Resources of the U. S., 1917, Part I), published Dec. 11, 1918; II: 20. Pent in 1917. By C. C. Osborn. (Mineral Resources of the U. S., 1917, Part II), published Dec. 19, 1918.

**NEW BUREAU OF MINES PUBLICATIONS:** War Mineral Investigations Series No. 7. Review of the Manganese Situation. By C. M. Weld, dated Dec., 1918; No. 5. Production of Ferromanganese in Blast Furnaces. By P. H. Royster, prepared in co-operation with the School of Mines of the University of Minnesota, dated December, 1918; An Absorption Method for the Determination of Gasoline in Natural Gas. By W. Y. Dykema and Roy O. Neal of the Bartlesville Station of the Bureau of Mines.

**THE UNITED STATES TARIFF COMMISSION** has issued its second annual report for the fiscal year ended June 30, 1918. The Commission has continued its preparation of a tariff information catalog for the purpose of facilitating legislation by Congress. The Commission has published several handbooks on different industries and has a number of others in preparation. The chemical and metallurgical industries have received special attention in the commodities that have been covered thus far by the Tariff Information Catalogs.

## Stocks and Bonds

Closing Bid and Asked Quotations Feb. 13, on N. Y. Stock Exchange

### CHEMICAL COMPANIES

	Bid	Ask		Bid	Ask
Am. Ag. Ch.	100	101	Mat. Al. Wk.	34	44
do. pf.	99	99	Ten. C. & C.	12	13
Barrett Co.	114	115	Un. Dyewood	60	61
do. pf.	109	111	do. pf.	90	95
Gen. Chem.	164	165	Va.-Car. Ch.	51	51
do. pf.	103	108	do. pf.	112	113
Int. Ag. Ch.	13	15			
do. pf.	56	58			

### Bonds

Am. Ag. Ch., 1st cv. 5s, '28	100	100
Am. Ag. Ch., cv. db. 5s, '24	100	100
Int. Ag. Ch., 1 mtg. & col. tr. 5s, '32	79	80
Va.-Car. Ch., 1 mtg. 5s, '23	95	96
Va.-Car. Ch., cv. db. 6s, '24	101	102

### PETROLEUM COMPANIES

	Bid	Ask		Bid	Ask
Asso. Oil Co.	71	74	P-A Pet & Tr	69	69
Cal. Pet.	23	23	do. pf.	120	125
do. pf.	68	69	Pierce Oil	17	17
Col. G. & E.	49	49	Royal Duteb	85	85
Mex. Pet.	172	172	Sinclair O & R	34	34
do. pf.	103	107	Texas Co.	189	190
Ohio Cit. Gas	39	39	Tex. Pac. Ld.		
do. pf.	43	44	Tr.	220	265
Ohio Fuel S.	43	44	Tidewater Oil	215	225
Okla. P. & W.	8	8			

### Bonds

Columbia Gas & Electric, 1 5s, '27	80	82
Col. G. & E., std. 1 5s, '27	81	81
Pan-Am. Pet. & Tr. 1 6s, '19-'27	112	112
Pierce Oil, cv. db. 6s, '24	91	91
Pierce Oil, cv. 5s, Notes, '20	100	101
Sin. O. & R. 1 1/2s, '20, with stk. war	98	99
Sin. O. & R. 1 1/2s, '20 without stk. war	95	96
Texas Co., db. 6s, '31	101	102
Union Oil of Cal. 1 5s, '31	93	93
United Fuel Gas 1 mtg. 6s, ser. A, '36	95	98

### IRON AND STEEL SECURITIES

	Bid	Ask		Bid	Ask
Am. St. F.	76	76	Pitta. Ste. pf.	92	92
Beth. Steel	60	61	Rep. Iron & Steel	73	73
do. class B	60	60	do. pf.	101	101
do. pf.	103	103	Sloss Shuff. I.		
do. pf. 75c	90	95	& S.	48	48
Central Fdry.	17	23	do. pf.	88	
do. pf.	31	33	Superior Steel	33	34
Col. F. & I.	36	36	do. 1 pf.	93	101
do. pf.	100	100	Trans. & W.		
Cruc. Steel	54	54	Steel	37	38
do. pf.	90	94	Un. Alloy St.	39	39
Great No. Ore	37	37	U.S.C.I.P. & F.	15	15
Gulf Sta. Steel	50	51	do. pf.	46	46
do. 1 pf.	94	99	U. S. Steel	90	90
Lack. Steel	64	65	do. pf.	114	114
Mid. St. & Ord	41	41	Va. Coal, I & C	55	60
Nova Scotia Steel	48	48			

### Bonds

Beth. Steel, 1 ext. gtd. S.F. 5s, '26	95	96
Beth. Steel, 1 1/2s, ref. 5s, Ser. A, '42	84	89
Beth. Steel, P. M. & I. S. F. 5s, '36	81	85
Buff. & Susq. Iron, 1 S. F. 5s, '32	85	96
Buff. & Susq. Iron, deb. 5s, '27		
Cent. Found. 1 mtg. S. F. 6s, '21	80	82
Col. F. & I., gn. S. F. 5s, '43	88	90
Ill. Steel, db. 4 1/2s, '40	84	85
Ind. Steel, 1 mtg. gtd. 5s, '52	92	98
Lack. Steel, 1 5s, '23	86	86
Lack. Ste., 1 con. mtg. cv. 5s, Ser. A, '50	86	87
Mid. St. & Ord., clt. cv. S. F. 5s, '36	97	98
Nat. Tube, 1 mtg. gtd. 5s, '52	94	95
Rep. I. & S., S. F. mtg. 5s, '40	91	95
Tenn. C. & I. R.R., gn. 5s, '51	100	100
U. S. Steel, S. F. 5s, '63	87	89
Va. C., I. & C., 1 5s, '49		